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Competition's Effect: Unveiling the Simultaneous Relationship between Risk and Cost of Financial Intermediation

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Abstract

This study examines the simultaneous association between risk and cost of financial intermediation (CoFI) by examining the effect of competition at different high-average-low levels from 2010 to 2021. The empirical findings of the two-step system generalized method of moments (2GMM) depict few significant insights based on 44 commercial banks in Bangladesh. The study finds that risk and CoFI are inversely related to each other in the short run and positively associated in the long run. Moreover, competition shows a heterogenous effect on risk and CoFI in both the short and long. However, in the long run, in a competitive market, incremental risk enhances CoFI, but a high CoFI target also increases risk. Finally, considering the CoFI, the average level of CoFI reduces the risk; however, considering risk, the high-risk and low-risk levels can enhance CoFI. Level of competition advocates average competition since it increases the cost of intermediation and reduces risk. Also, in average-level competition, incremental risk significantly increases the CoFI. This study provides a banking balancing act of risk-return tradeoff and Structure-Conduct-Performance (SCP) paradigm policy implications for emerging nations' financial system growth.

JEL classification numbers: C30, C50, G21, G32.
Keywords: Cost of Financial Intermediation, Risk Management, Competition, Two-step system GMM, Simultaneous relationship.

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1. Introduction

Banks, the prime matchmaker of the financial system, have always struggled to cope with risk. Globally, the primary objective of commercial banks is to make a profit, and this profit-making pressure leads them to take more risks. In an economic system, banks play an essential and central role in mobilizing funds from surplus units (households) to deficit units (business, investment sector) (Allen & Santomero, 1998; Gupta et al., 2021). Financial systems can be analyzed from two perspectives: functional perspectives and institutional perspectives. However, the functional perspective supersedes the institutional perspective (Merton, 1995). This is because the practical view is steadier than its counterparts.

According to the functional perspective, as an intermediary organization, banks profit from the intermediation between the flow of funds from depositors to borrowers. Financial intermediation theory advocates risk management as an essential function of banks (Gupta et al., 2021; Scholtens & Wensveen, 2000), especially default risk and interest rate risk (Pagano, 2001), to maximize the shareholders' wealth of the Bank (Allen & Santomero, 1998) and to keep total risk at a manageable level (Pagano, 2001). The revenue obtained from providing those services aids in calculating the total CoFI. Saunders and Schumacher (2000) defined the cost of financial intermediation or net interest margin as the gap between incomes and expenses as a proportion to interest-earning assets. Higher margins, i.e., banks' fees are higher than the generally accepted optimal rate in society, indicate that the banks are not operating efficiently (Peia & Vranceanu, 2018). To promote the country's economic growth, banks must maintain low costs of financial intermediation (hereafter, CoFI) (Tarus et al., 2012). Low intermediation costs imply a generally competitive banking sector (Saunders & Schumacher, 2000). Certain degrees of market power are deemed appropriate for the banking industry to ensure stability (Rakshit & Bardhan, 2019). Examining the simultaneous connection between risk-taking tendency and the CoFI and the impact of competition is worthwhile for banks to explore. The reality is more worthy from an Asian country perspective (Zheng et al., 2018).

Competition plays a noteworthy role in enhancing the quality of financial products, financial inclusion, and economic prosperity, though market power significantly impacts banks' prices and intermediation costs (Ventouri, 2018). According to the moral hazard theory, competition leads to a moral hazard issue for banks since it postulates low capitalized banks take more risk that increases future risk, eliminates profit, and boosts gambling intentions (Hellmann et al., 2000; Zheng, Gupta, et al., 2017). Therefore, banks accelerated their risk-taking behavior (Allen et al., 2011; Marcus, 1984). Commercial banks operate within regulatory constraints (Hellmann et al., 2000), so they inject liquidity into the economy to stimulate it by following the relaxation of the monetary policy of the Central Bank. However, relaxation of the monetary policy may not work if banks have greater market power. So, market power is essential for the lending channel and funding structure (Dang & Huynh, 2022), which in turn helps in developing capital for the banks. Banking industries

witnessed meaningful changes in the competition after the financial crisis in 1997-1998 in Asia and 2008-2009 in World (Khan et al., 2016; Olivero et al., 2011).

After analyzing the available literature and ongoing debate, some research questions are yet to be addressed. Firstly, how do risk-taking and CoFI impact each other in a bidirectional manner while considering simultaneous relationships? Secondly, does the competition have any transmission effect on the concurrent relationship of both variables?

Hence, the main objective of the study is to delve into the concurrent association between risk and the CoFI having a transmission effect of competition. Specifically, we look at the bidirectional association between risk and CoFI from the context of the dataset of the commercial banks and investigate whether competition can influence the simultaneous relations between risk and CoFI.

This research study makes several significant contributions to the existing empirical literature on the banking market. First, prior studies have paid less attention to the concurrent relationship between risk and the CoFI and the transmission impact of competition on that relationship. Furthermore, evidence in the prevailing literature examining the transmission effect of competition on the Risk-CoFI nexus is scarce. However, unlike previous studies, this study uniquely examines how competition impacts the concurrent association between risk and CoFI. Second, we included a quadratic term of risk, CoFI, and competition to check for the possible non-linearities in the relationship between risk and the CoFI. To further explore this relationship, we employed risk dummies, CoFI dummies, and Competition dummies and categorized each variable into three levels: High, Low, and Average. Finally, we also examine the influence of risk on CoFI as well as the effect of CoFI on risk-taking in the presence of competition. To do so, we incorporate interactions between competition and risk ratio and between competition and CoFI ratio. Our research is conducted in Bangladesh's banking industry, which has undergone numerous capital regulation reforms over the past thirty years, making it an ideal environment for our hypothesis testing. Additionally, the banking sector in Bangladesh is influenced by new entrants, with new banks being established every ten years after liberation (Gupta et al., 2021; Yesmin, 2018). Our findings may have implications for other emerging economies with alike economic circumstances.

The visual representation of the research's theoretical structure is depicted below in Figure 1.

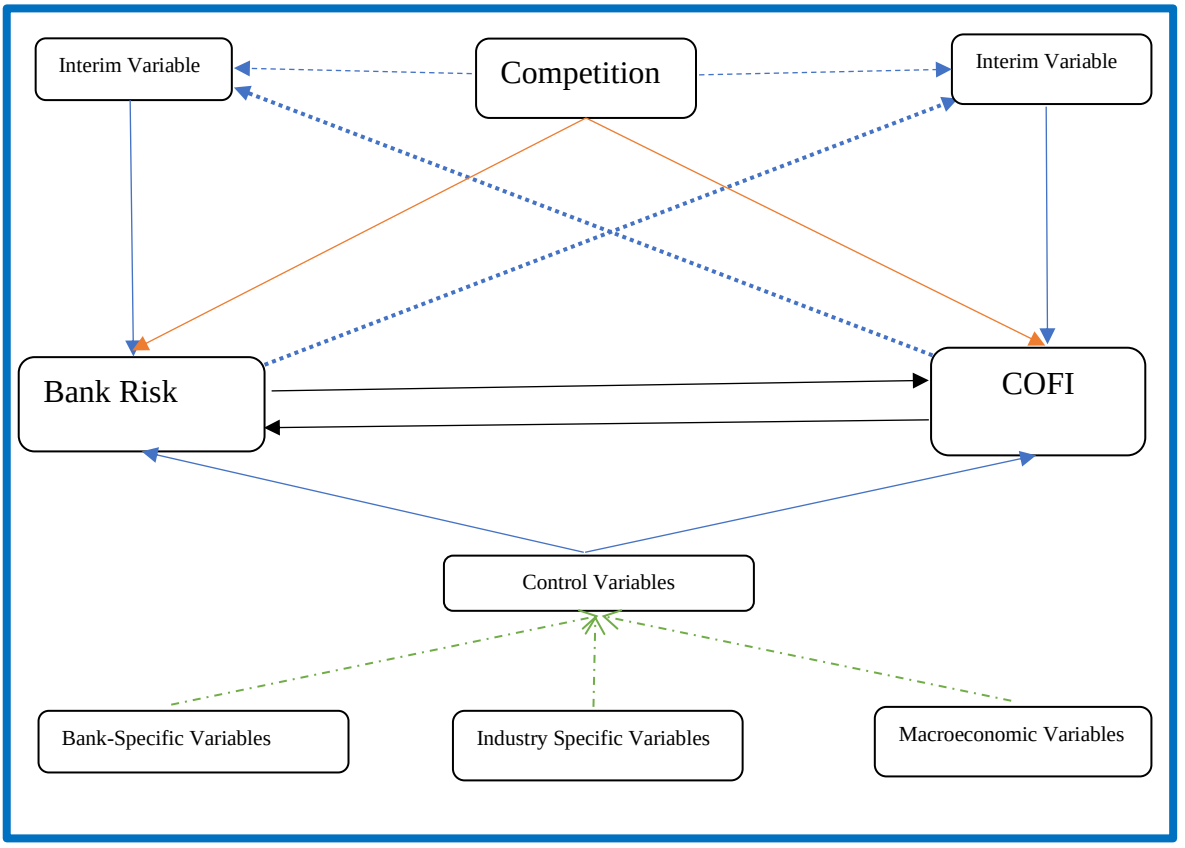

Figure 1: Effect of competition on the reciprocal association between bank risk and COFI

The rest of the paper is organized into four sections. Sections 2, 3, 4, and 5 encapsulate a literature review, methodology, empirical findings, and conclusion.

2. Literature review

2.1 Theoretical Literature

Banks, the prime intermediaries of the financial market, often intend to take riskier investments to have superior returns and cope with intense competition (Jiang et al., 2020). This tendency to increase loan portfolio risk is linked to the concept of moral hazard (Berger & DeYoung, 1997), a term that originated in the insurance industry (Rowell & Connelly, 2012) and refers to a lack of incentive to act responsibly (Varian, 2010). There are two competing theories concerning the influence of competition on bank behavior and financial stability. The competition-stability hypothesis suggests that increased competition leads to enhanced financial stability as banks become more cautious and avoid excessive risk-taking to maintain their reputation in the market (Berger et al., 2009; Moudud-Ul-Huq et al., 2023). Conversely, the competition-fragility hypothesis posits that competition can lead to greater risk-taking to gain or retain market share (Allen & Gale, 2004; Keeley,

1990). Market concentration can also influence bank behavior and performance. Banks with a higher market share may be less competitive and more likely to engage in collusive behavior to increase profits (Bushashe, 2023; Saif-Alyousfi & Saha, 2021). This relationship between market concentration, bank behavior, and performance is known as the structure-conduct-performance (SCP) framework.

2.2 Empirical Literature

Regulations and deregulation are ongoing processes that the banking industry must deal with. There is always regulatory pressure to control banks' risks. Central banks impose different regulatory pressures, including capital regulations, on commercial banks to shrink their risk-taking capacity and tendency. However, banks' capacity for earning is also related to their asset exposure and risk-taking. Thus, the bank's risk-taking and earning capacity are interrelated. Therefore, intermediation costs significantly affect the risk to banks and vice versa (Das Gupta et al., 2021). In this case, banks need to focus more on managing the CoFI (Zarruk, 1989). The relationship between interest fluctuations and interest margin was identified by Samuelson (1945) in his study. The net margin of interest is also expressed by the CoFI (Jarmuzek & Lybek, 2020; Khan et al., 2022; Poghosyan, 2013). In the Model of bank margin, popular as the dealership model, Ho and Saunders (1981) mentioned the bank as a risk-averse dealer of funds. They identified the degree of risk aversion, size, market structure or competition, and interest rate risk as the determining factor of interest margin.

Further extension is also observed in the study of McShane and Sharpe (1985), Allen (1988), Angbazo (1997), and others. Considering the context of Australian trading banks, McShane and Sharpe (1985) did their research grounded on the hedging doctrine of interest margin determination of Ho and Saunder (1981); they found that CoFI has a significant nonlinear connection with the risk, competition, size, and interest rates volatility. Allen (1988) extended the dealership model by focusing on heterogeneous loans and deposits instead of homogenous ones.

Angbazo (1997) extended the dealership model as a dynamic model by adding default risk and making an interaction between default risk and the interest rate risk. The author found that for money-center banks, CoFI significantly affects credit risk but has no meaningful association with interest rate risk. However, regional banks depict the opposite results of money-centered banks. Following Lerner (1981) criticism of Ho and Saunders (1981) dealership model, Maudos and Fernández de Guevara (2004) enhanced the dealership model by incorporating operating costs as CoFI predictors. According to Saunders and Schumacher (2000), a lower level of CoFI indicates a relatively competitive banking system. However, a higher margin can stabilize the system by allowing banks to absorb crisis and economic shocks. In addressing the concurrent effect of CoFI, efficiency, and bank risk-taking, Das Gupta et al. (2021) opined that credit risk inversely affects the CoFI. The negative association between credit risk and CoFI was also found by Marinković and Radović (2014), Balla and Rose (2019), and Khan and Jalil (2020).

Inversely, a positive association is also observed in the literature. The extended dealership model of Cruz-García and Fernández de Guevara (2019) explores the positive association between credit risk and CoFI. The positive association was also found by Wong (1997), Poghosyan (2010), Naceur and Omran (2011), Tarus et al. (2012), and Poghosyan (2013), among others. However, Islam and Nishiyama (2016) show an insignificant association between these two.

The skewness of information is a significant factor that provides a bank with a competitive advantage over others in the banking industry. Thus, competition is essential to maintaining the stability of the banks (Alvi et al., 2021; Bouckaert & Degryse, 2006). Schaeck and Cihák (2014) formulate the transmission mechanism proposition and argue that competition increases the competence and viability of banks. Jiang et al. (2020) employed quantile regression techniques on a dataset of 135 Chinese banks to perform a study on the impact of capital on bank risk, and they concluded that competition aids in lowering bank risks. The significant inverse connection between competition and risk is also supported by Sijabat et al. (2020), Saeed et al. (2020), Su et al. (2020), Mateev et al. (2021); and Santoso et al. (2021). Zheng et al. (2017b) found that competition increases bank risks after studying 191 commercial banks in Bangladesh, China, and India. The positive alliance between bank risks and competition is also evidenced by Bushman et al. (2016), Sirait and Rokhim (2019), Davis et al. (2020), and Gupta et al. (2021). The study of Mateev et al. (2022) supports the competition-stability hypothesis, but their studies showed mixed evidence about the relationship between competition and risks. On the other hand, Davis et al. (2020) support the hypothesis of competition-fragility. The mixed results were also evidenced by Tan and Floros (2013); Dima et al. (2014); Balla and Rose (2019); Hussain and Bashir (2020); Nguyen et al. (2021); and Mateev et al. (2021).

The competition also significantly affects the operation of the CoFI. Because the more significant the market power, the greater the spread, which means competition decreases the CoFI (Maudos & Fernández de Guevara, 2004; Saunders & Schumacher, 2000). The negative association between competition and CoFI is also supported by Marinković and Radović (2014), Sirait and Rokhim (2019), Khan and Jalil (2020); Cruz-García and Fernández de Guevara (2019); and Santoso et al. (2021). However, Wong (1997) and Tarus et al. (2012) showed that CoFI might rise due to competition. McShane and Sharpe (1985) and Gupta et al. (2021) concluded that competition has a significant nonlinear relationship with the net interest margin. Considering the discussion above, we construct the following hypothesis portraying the connection between risk and CoFI and the influence of competition in exploring the relationship between risk and CoFI.

H_1: The CoFI has a significant non-linear inverse effect on bank risk-taking.
H_2: Risk has a significant non-linear negative effect on the CoFI.
H_3: Competition significantly mediates the relationship between risk and the CoFI.

3. Methodology of the Study

This section explains the data, variables, and techniques used for empirical analysis.

3.1 Data Collection

Bank balance sheet data spanning from 2010 to 2021 for empirical examination has been acquired from the annual reports of the selected banks. Macroeconomic and industry-level variables have been obtained from the World Bank database. Bangladesh hosts a total of 61 scheduled banks, consists of State-owned Commercial Banks (SOCBs), Specialized Banks (SBs), Foreign Commercial Banks (FCBs), and Private Commercial Banks (PCBs) (Gupta & Yesmin, 2022). Initially, all commercial banks operational in the country were encompassed in the sample. However, a refined sample list was generated by applying specific screening criteria. This involved the exclusion of FCB and SB due to non-availability and irregular reporting, removing banks with less than five years of consecutive annual reports, and excluding extreme outlier values from the dataset. After eliminating missing data for 2010-2021, the dataset comprises 494 unbalanced panel observations from 44 commercial banks.

3.2 Description of variables

The variables used to investigate the association among bank competitiveness, risk, and CoFI are shown in detail below.

3.2.1 Dependent Variables

Risk Measures: Following the previous study (Mateev et al., 2021), to assess the bank's risk, we utilized the widely accepted ratio of non-performing loans to total loans (RNPL) - a key component of financial statements that measures credit risk. In addition, we included a quadratic term of this measure to account for probable non-linearities in the relationship between risk and the CoFI. To further explore this relationship, we employed risk dummies categorized into three levels: High ($\geq \overline{Risk} + 0.5\sigma_{Risk}$), Average ($> \overline{Risk} - 0.5\sigma_{Risk}\ and < \overline{Risk} + 0.5\sigma_{Risk}$), and Low ($\leq \overline{Risk} - 0.5\sigma_{Risk}$). This categorization is based on how far the risk deviates from its mean value regarding its standard deviation (σ). Categorizing risk this way enabled us to identify potential non-linearities in the model. Additionally, we tested the model's resilience by using the ratio of loan loss provision to total loans as a complementary measure of risk, thereby ensuring the accuracy of our findings.

Cost of Financial Intermediation Measures: Following the literature of Rahman et al. (2018) and Gupta et al. (2021), we measure the CoFI1 with the ratio of net interest income over average total earning assets; a higher proportion of the variables indicates a higher CoFI and vice versa. Here, we also included a quadratic term of this CoFI1 measure to account for probable non-linearities in the connection between CoFI and risk. Moreover, we employed CoFI dummies to explore this relationship further into three levels: High ($\geq \overline{CoFI} + 0.5\sigma_{CoFI}$), Average

($>\overline{CoFI} - 0.5\sigma_{CoFI}\ and < \overline{CoFI} + 0.5\sigma_{CoFI}$), and Low ($\leq \overline{CoFI} - 0.5\sigma_{CoFI}$). We also tested the model's robustness by using the ratio of net interest income over average total assets (CoFI2).

3.2.2 Independent Variables

Market Competition: Following the literature of Mateev et al. (2022), Gupta and Yesmin (2022), Faia et al. (2021), Hussain and Bashir (2020), Kasman and Kasman (2015), among others, this study also opted for Boone indicator (BI) and Lerner Index (LI) to inspect the competition effect.

The BI (Boone, 2008) is an effective model that addresses the issue of theoretical market concentration measures, such as the Herfindahl-Hirschman Index (van Leuvensteijn et al., 2013). This model assumes that competition drives efficient firms to perform better while weakening the inefficient ones. It also assumes that banks prioritize profit maximization despite other important objectives, such as risk minimization, wealth maximization, etc. Moreover, it assumes that firms behave competitively when faced with changes in market competition, although their behavior may differ under various business conditions. Despite its limitations, the BI remains a popular measure of market competition (Tabak et al., 2012; Zheng et al., 2017b). The empirical Model used by van Leuvensteijn et al. (2013) to estimate BI is:

$$\ln (ms)_{it} = \alpha + \beta_t ln(mc_{it}) + \sum_{t=1}^{T-1} \gamma_t d_t + \varepsilon_{it} \quad (1)$$

Where parameters are represented by α, β, and γ, i and t refer to the bank and time, ms and mc denote the market share and marginal costs of the respective bank, d_t is a time dummy, and ε is the error term. β_t is likely to have a negative sign since a more competent bank will get a larger market share. Nevertheless, because information on the BI is no longer presented in the World Bank databases after 2017, we empirically determine BI's value from the aggregate industry data as Schaeck and Cihák (2014) did. The Model for estimating BI is:

$$\pi_{it} = \alpha + \beta \ln (MC_{it}) \quad (2)$$

Where π_{it} is the profit measure of bank' i' at the time 't' as measured by return on assets (ROA), β denotes the BI. We use average variable cost as a proxy of marginal cost, as Schaeck and Cihák (2014) and Boone (2008) suggested. We calculate the value of the competition measure by regressing the logarithm of ROA (ln ROA) on the logarithm of average variable cost (ln MC).

BI is oppositely proportional to competition, meaning a more negative measure indicates a more competitive market. To establish direct proportionality to competition, we use the inverse of the BI (i.e., $-\beta_t$) by following the study of Tabak et al. (2012). We incorporated a quadratic term to check for any probable non-

linear impacts of competition on the relationship between risk and financial intermediation costs. To further investigate this association, we divided the competition by employing competition dummies into three categories: High ($\geq \overline{BI} + 0.5\sigma_{BI}$), Average ($> \overline{BI} - 0.5\sigma_{BI}\ and < \overline{BI} + 0.5\sigma_{BI}$), and Low ($\leq \overline{BI} - 0.5\sigma_{BI}$). This categorization helped us identify potential non-linearities in the model.

We have also utilized the Lerner Index (LI) to assess competition. This index is frequently employed to gauge market power and competition. The LI estimates a bank's pricing power or markup over its marginal costs, with the formula being: Lerner index = $\frac{P_{i,t}-MC_{i,t}}{P_{i,t}}$, where $P_{i,t}$ is the price of the total asset of the bank "i" in time "t". $MC_{i,t}$ is the marginal cost of total assets (Hussain & Bashir, 2020). The LI ranges from 0 to 1, with 0 indicating perfect competition where a bank sets prices equal to its marginal costs and has no market power. Conversely, a value of 1 means that the bank possesses high market power, implying a monopoly where the bank charges prices above its marginal cost.

The following table provides detailed estimates of other variables:

Table 1: Definition of the variables

Classification	Variable	Description	References
Risk	RNPL	Loan Non-performing Loan to Total Loan	Barra and Ruggiero (2021)
	RLLP	The ratio of Loan Loss Provision to Total Loan	Mateev et al. (2021)
Cost of Financial Intermediation	CoFI1	$CoFI = \frac{Net\ Interest\ Income}{Average\ Total\ Earning\ Assets}$	Naceur and Kandil (2009)
	CoFI2	$CoFI2 = \frac{Net\ Interest\ Income}{Average\ Total\ Assets}$	Gupta et al. (2021)
Independent Variables			
Market Competition	BI	BOONE Indicator: Competition Proxy. $\pi_{it} = \alpha + \beta \ln(MC_{it})$ Where β denotes the Boone Indicator	Hussain and Bashir (2020)
	LI	Lerner Index: The difference between price and marginal cost divided by price. LI = $\frac{P_{i,t}-MC_{i,t}}{P_{i,t}}$	Khan and Jalil (2020)
Banking sector Development	BSD	Banking Sector Development = Banking industry asset to gross domestic product	Gupta et al. (2021)

Gross domestic product	GDP	Growth of the gross domestic product (Per capita growth)	Nguyen et al. (2021)
Inflation	Inflation	Annual Rate of Inflation (%) (Consumer Prices)	Mujtaba et al. (2021)
Capital	ETA	Equity to total assets ratio	Abbas and Younas (2021)
Size	Size	The logarithm of the total assets	Mujtaba et al. (2021)
Profitability	ROA	The ratio of net-income to total assets	Saeed et al. (2020)
Liquidity	LTD	The ratio of loans to deposit	Zheng, Rahman, et al. (2017)
Income Diversification	ID	The ratio of non-interest revenue to total assets	Zheng et al. (2017b)
Operating Cost	NIETA	The ratio of non-interest expenses to total assets	Khan and Jalil (2020)
High Comp	Dummy Variable	Equal to 1, If $BI \geq \overline{BI} + 0.5\sigma_{BI}$, otherwise 0	Tabak et al. (2012)
Low Comp	Dummy Variable	Equal to 1, If $BI \leq \overline{BI} - 0.5\sigma_{BI}$, otherwise 0	Tabak et al. (2012)
Avg Comp	Dummy Variable	Equal to 1, If $\overline{BI} - 0.5\sigma_{BI} < BI < \overline{BI} + 0.5\sigma_{BI}$, otherwise 0	Tabak et al. (2012)
High CoFI	Dummy Variable	Equal to 1, If $CoFI1 \geq \overline{CoFI1} + 0.5\sigma_{CoFI1}$, otherwise 0	Source: The Authors
Low CoFI	Dummy Variable	Equal to 1, If $CoFI1 \leq \overline{CoFI1} - 0.5\sigma_{CoFI1}$, otherwise 0	Source: The Authors
Avg CoFI	Dummy Variable	Equal to 1, If $\overline{CoFI1} - 0.5\sigma_{CoFI1} < CoFI1 < \overline{CoFI1} + 0.5\sigma_{CoFI1}$, otherwise 0	Source: The Authors
High Risk	Dummy Variable	Equal to 1, If $RNPL \geq \overline{RNPL} + 0.5\sigma_{RNPL}$, otherwise 0	Source: The Authors
Low Risk	Dummy Variable	Equal to 1, If $RNPL \leq \overline{RNPL} - 0.5\sigma_{RNPL}$, otherwise 0	Source: The Authors
Avg Risk	Dummy Variable	Equal to 1, If $\overline{RNPL} - 0.5\sigma_{Boone} < RNPL < \overline{RNPL} + 0.5\sigma_{RNPL}$, otherwise 0	Source: The Authors

3.3 Inflection Point

We incorporated the squared terms of CoFI, risk, and Boone indicator into various specifications to explore potential non-linear relationships. Following Hussain and Bashir (2020), we compute point of inflection to interpret the results of these variables and their squared terms. To make sense of the results, we followed the interpretation approach of Berger et al. (2009) and Hussain and Bashir (2020). An inflection point refers to the point (in slope) where the connection between variables experiences a significant shift, such as an alteration in sign from positive to negative or vice versa.

$$\text{Inflection Point} = \frac{-\,coefficient\ of\ dependent\ variable}{2\times coefficient\ of\ the\ squared\ term\ of\ that\ variable} \quad (3)$$

3.4 Empirical Framework and Strategy

Following the study of Zheng et al. (2023), Moudud-Ul-Huq et al. (2023), Gupta et al. (2021), Boulanouar et al. (2021), Soedarmono and Tarazi (2013), and Nguyen (2012) this study utilized the 2GMM of Arellano and Bond (1991) and Arellano and Bover (1995). The 2GMM model controls for endogeneity by internally transforming the data and including the dependent variables' lagged values. To ensure the model's accuracy, two standard tests (AR 1 and 2 and the Hansen test) are performed.

Following the studies of Gupta et al. (2021), Khan and Jalil (2020), and Zheng et al. (2017a), we specify the baseline model (Simultaneous equations):

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t} + \beta_q \sum_{q=3}^{7} B_{i,q,t} + \beta_8 I_{i,r,t} + \beta_s \sum_{s=9}^{10} M_{i,s,t} + \varepsilon_{i,t} \quad (4)$$

The subscript i and t represent cross-sectional dimensions across banks and time, respectively. Again, q, r, and s represent bank-specific, industry-specific, and macroeconomic-specific perspectives. B, I, and M are vectors of bank-specific, industry-specific, and macroeconomic-specific control variables, respectively. $\varepsilon_{i,t}$ is i.i.d (independent and identically) distributed error term.

'$Y_{i,t}$' denotes the dependent variable – risk and the CoFI. $Y_{i,t-1}$ represents the lagged dependent variable. $X_{i,t}$ denotes to the endogenous independent variables; for the risk equation, the cost of financial intermediation is the endogenous independent variable, while for the cost of financial intermediation equation, the risk is the endogenous independent variable. Bank-level control variables are presented by $B_{i,q,t}$, which includes capital, income diversification, size, profitability, and liquidity ratio for risk measures; and includes capital, size, operating cost, income diversification, and liquidity ratio for CoFI measures. $I_{i,r,t}$ presents an industry-specific variable, which includes BSD. $M_{i,s,t}$ represents macroeconomic variables, including GDP and inflation. We needed to empirically determine the model variables to estimate equation (4). Table 1 describes the empirical proxy for each of these variables.

We extended our baseline equation in the footsteps of Kasman and Kasman (2015), Hussain and Bashir (2020), Gupta et al. (2021), and Gupta and Yesmin (2022) by taking the non-linear terms of the endogenous independent variables and adding the competition variables to analyze the impact of competition. The extended models are presented in equations (5), (6), and (7) as follows:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t} + \beta_3 X^2{}_{i,t} + \beta_q \sum_{q=4}^{8} B_{i,q,t} + \beta_9 I_{i,r,t} + \beta_s \sum_{r=10}^{11} M_{i,s,t} + \varepsilon_{i,t} \quad (5)$$

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t} + \beta_3 Comp_{i,t} + \beta_4 Comp^2{}_{i,t} + \beta_q \sum_{q=5}^{9} B_{i,q,t} + \beta_{10} I_{i,r,t} + \beta_s \sum_{r=11}^{12} M_{i,s,t} + \varepsilon_{i,t} \quad (6)$$

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t} + \beta_3 Comp_{i,t} * X_{i,t} + \beta_4 Comp^2{}_{i,t} * X_{i,t} + \beta_q \sum_{q=5}^{9} B_{i,q,t} + \beta_{10} I_{i,r,t} + \beta_s \sum_{r=11}^{12} M_{i,s,t} + \varepsilon_{i,t} \quad (7)$$

Equation (5) presents the non-linear effect of endogenous independent variables on the dependent variable. Equation (6) includes the competition as the industry-specific variable and shows the non-linear effect of competition on the dependent variables. Equation (7) presents the nonlinear and joint effect of the competition and endogenous independent variables on the dependent variables. In equations (5), (6), and (7) X^2 and $Comp^2$ refer to the squared terms of risk, CoFI, and competition, respectively. In equation (6), the product of $Comp_{i,t} * X_{i,t}$ addressed the joint effect of competition with the endogenous independent variable on the dependent variable. The product of $Comp^2{}_{i,t} * X_{i,t}$ addressed the nonlinear joint effect of competition with the endogenous independent variable on the dependent variable.

4. Empirical Findings and Discussion

This section describes the summary statistics (Table 2) and multicollinearity test (Tables 3-4). A 2GMM panel estimator is used to estimate the empirical results (Table 5-12). The Hansen over-identification test is employed to check the instruments' validity. Our instruments are verified as accurate in all Tables 5-12 specifications. Table 4 represents the pairwise correlation among variables. Table 3 shows the test result of the variance inflation factor (VIF) concerning risk and CoFI. As no correlation among independent variables exceeds 0.7 and the value of the VIF is below 10 (Thompson et al., 2017), we can assume that multicollinearity does not exist.

4.1 Descriptive Statistics

Descriptive statistics of Table 2 show that the average value of risk measure NPL is 78%, higher than the average ratio in European, which is 47.15% (Ferri & Pesic, 2017), indicating that banks generally take more risks. The alternate measure of risk LLP depicts the mean value of 0.031. The mean values of CoFI 1 and CoFI 2 are 2.3% and 2 %, respectively, which is lower than the average for South Asia (2.98%) (Islam & Nishiyama, 2016), Asia Pacific (3.0%) (Fu et al., 2014), and Latin America (9.85%) (Chortareas et al., 2012). The mean value of income diversity is 2.5%, which means banks are stable regarding diversified funding sources and can protect the funding fragility. However, this is higher than that of the MENA region (2.3%) (Mateev et al., 2021). The average profitability value is 0.899%, with a standard deviation of 1.103. The mean operating cost value is 1.04%, with a standard deviation of .523. The competition measures Boone indicator has shown an average value of -3.207 (inverse Boone indicator is 3.207), which is lower than that of the Asian mean value of -7.50% (Zheng et al., 2017b) but better than the Chinese bank average of -0.02682 (Hussain & Bashir, 2020), indicating that commercial banks are operating in a less competitive environment when compared to the Asian average.

Table 2: Descriptive Statistics of the Variables

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
RNPL	494	0.078	0.103	0.000	0.598
RLLP	494	0.031	0.043	0.000	0.351
COFIT1	494	0.023	0.014	-0.024	0.104
COFIT2	494	0.020	0.012	-0.023	0.077
BI	494	3.207	2.878	0.082	8.602
LI	494	0.558	0.151	0.444	0.903
ETA	494	0.100	0.089	-0.077	0.808
ID	494	0.025	0.012	0.000	0.101
Size	494	12.036	1.017	8.508	14.355
NIETA	494	1.040	0.523	0.000	3.747
ROA	494	0.899	1.103	-7.490	6.050
LTD	494	0.850	0.167	0.021	2.621
BSD	494	48.044	2.856	41.054	51.110
GDP	494	5.122	1.082	2.271	6.688
Inflation	494	6.539	1.532	5.514	11.395

The average value of the gross domestic product is 5.122 with a standard deviation of 1.082, which is lower than the same (9.977065) of China (Hussain & Bashir, 2020) and also than the Asian average of 5.97% (Islam & Nishiyama, 2016), but better than the Asian Pacific average of 3.96% (Fu et al., 2014). However, the inflation rate is in good condition, considering the Asian average of 7.04% (Islam & Nishiyama, 2016). However, the mean value of macroeconomic variable inflation is 6.54% with a standard deviation of 1.532, industry level variable BSD is 48.044 with a standard deviation of 2.856, and the bank level control variable size is 12.036 with a standard deviation of 1.017 and loan to deposit is 85.045 with a standard deviation of 16.688.

Table 3: Variance Inflation Factor

Variable	VIF (Risk Equation)	VIF (CoFI Equation)
RNPL		**1.195**
CoFI 1	**1.705**	
BI	**1.786**	**1.779**
ETA	**1.923**	**1.891**
ID	**1.41**	**1.281**
Size	**1.991**	**2.088**
ROA	**1.662**	
NIETA		**1.365**
LTD	**1.241**	**1.142**
BSD	**1.508**	**1.5**
GDP	**1.479**	**1.455**
Inflation	**1.44**	**1.387**

Table 4: Pairwise Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
RNPL	1.000														
RLLP	0.865	1.000													
COFI1	-0.564	-0.522	1.000												
COFI2	-0.598	-0.554	0.994	1.000											
BI	0.069	0.020	0.071	0.075	1.000										
LI	-0.026	-0.006	-0.196	-0.194	-0.624	1.000									
ETA	-0.052	-0.043	0.200	0.194	0.056	-0.139	1.000								
ID	0.018	0.048	-0.117	-0.132	-0.106	0.022	-0.054	1.000							
Size	0.135	0.207	-0.291	-0.299	-0.015	0.167	-0.669	-0.006	1.000						
NIETA	-0.294	-0.284	0.483	0.482	0.057	-0.111	0.171	0.265	-0.318	1.000					
ROA	-0.572	-0.566	0.443	0.453	-0.068	-0.011	0.136	0.364	-0.159	0.189	1.000				
LTD	-0.205	-0.205	0.314	0.316	0.025	0.070	-0.161	-0.125	0.067	0.064	0.126	1.000			
BSD	-0.009	0.011	0.020	0.010	0.345	-0.506	0.167	0.025	-0.177	0.096	-0.028	-0.168	1.000		
GDP	0.064	0.020	0.130	0.136	0.391	-0.645	-0.018	-0.114	0.028	0.028	-0.059	0.055	-0.225	1.000	
Inflation	-0.149	-0.108	0.182	0.173	-0.348	-0.001	0.073	0.307	-0.208	0.056	0.310	-0.066	0.023	-0.151	1.000

4.2 Effect of CoFI and Market Competition on Bank Risk-taking

Table 5 demonstrates how the CoFI and market competition affect bank risk. The regression coefficient of the lag-dependent variable is significant, inferring that the previous year's effect transfers to the prevailing year and the risk ratio is consistent. The negative relationship between the CoFI and risk (NPL) in Model I implies that higher CoFI leads to lower risk, and the banks that can generate more CoFI generally take lower credit risk. This finding is aligned with Rahman et al. (2018).

Bank variables react differently to risk. Capital demonstrates a significant negative relationship with risk, implying that well-capitalized banks tend to take less risks than their counterparts. This result is in line with the findings of Anginer et al. (2021) and incongruent with the findings of Mateev et al. (2021). Income diversification has a significant positive relationship with risk, implying that banks with multiple funding sources are more exposed to risks. This result aligns with the research findings of Mateev et al. (2022). Bank sizes have a significant inverse relationship with risk. This finding support the findings of Saif-Alyousfi and Saha (2021). Profitability has demonstrated a significant inverse alliance with risk, inferring that profitability reduces bank risks. Reservation of more liquidity reduces credit risk significantly, depicted by a negative association between risk and liquidity. This implies that a higher level of liquidity allows banks to manage unexpected risks and challenges better.

BSD (industry-level variable) has a noteworthy inverse connotation with risk, implying that as the banking sector develops, the prevalence of risk tends to decrease. The macroeconomic variable GDP also demonstrates a significant positive association with risk. This result suggests that as economic activity expands, the demand for credit also increases, which in turn leads to increased risks. This outcome is consistent with Zheng, Moudud-Ul-Huq, et al. (2017). Moreover, inflation has shown a significant negative relationship with risk. This result supports the findings of Jiang et al. (2020).

The findings of equation (5) – equation (7) related to the non-linear and joint effect of the CoFI and competition on risk are shown in Model (II) to Model (VI) of Table 5. Model II represents the non-linear effect of CoFI, Model III and Model V demonstrate the linear and non-linear effect of competition on risk, and Model IV and Model VI demonstrate the joint effect of competition and CoFI on risk.

Model II of Table 5 reveals a significant U-shaped correlation between CoFI and risk. To evaluate the nature of the association between the variables in quadratic equations, we estimate the inflection of the equation and contrast it with the data distribution. The inflection point for the equation is at 0.01915, which happens at around the 33rd percentile of the CoFI1 distribution. This means there is an inverse connection between CoFI and bank risk until the inflection point is reached. But after that point, the relationship becomes positive. Furthermore, we also identify the different categories of possible relationships between CoFI and bank risk. We divide CoFI into three categories: high, average, and low. It is apparent from columns I, II, and III of Table 6 that banks with both high and low CoFI tend to take

more risk. Conversely, banks with an average CoFI exhibit lower risk-taking behavior and display an inverse association between risk and CoFI. Put differently, this suggests that banks with low or high CoFI levels may be at greater risk than those with average CoFI levels. However, The positive relationship between High COFI and bank risk suggests that charging more COFI indicates suboptimal risk management by banks (Claeys & Vander Vennet, 2008).

Based on Model III, there is a significant U-shaped association between competition (measured by inverse BI) and bank risk. Model V reveals that market power (measured by the LI) has a significant inverse U-shaped relationship with risk. In Model III, the inflection point is 4.7916, approximately the 73rd percentile of the BI distribution, meaning that the relationship between competition and bank risk is negative up to the inflection point. However, after that point, the relationship becomes positive. Moreover, in Model V, the inflection point is 0.5939, around the 69th percentile of the LI distribution, meaning that the rest of the 31% of the data lies above the inflection point. These interactions highlight that the impact of competition on risk-taking is shaped like a U. These findings are incongruent with the findings of Tabak et al. (2012) and Hussain and Bashir (2020). We also identify the different categories of possible relationships between competition and risk. We divide bank competition into three categories: high, average, and low. It is apparent from columns IV, V, and VI of Table 6 that highly competitive and low-competitive banks tend to engage in riskier behavior, while average-competitive banks tend to take less risk. As a result, we can infer that our findings lend support to (yet also contradict) both the "competition-fragility" and "competition-stability" hypotheses regarding Bangladeshi banks (see, e.g., (Tabak et al., 2012).

In Model IV, the interactions between the inverse BI and CoFI and between the squared term of the inverse BI and CoFI show that the effect of CoFI on bank risk-taking is a U-shape as a function of the BI. Again, in Model VI, the interactions between the LI and CoFI and between the squared term of the LI and CoFI show that the effect of CoFI on bank risk-taking is an inverse U-shape as a function of the LI. These interactions highlight that the impact of CoFI on risk-taking is shaped like a U as competition levels fluctuate. The positive coefficient of interaction between the high competition dummy and CoFI, the positive coefficient of interaction between the low competition dummy and CoFI, and the negative coefficient between the average competition dummy and CoFI in columns VII to IX of Table 6 support this result. These findings indicate that the CoFI of highly competitive and low competitive banks positively affects their risk-taking. However, in the case of average competitive banks, the impact of CoFI on risk-taking is negative. The findings suggest that the increased expenses associated with financial intermediation lead highly competitive and low-competitive banks to undertake higher levels of risk. However, the average-competitive banks can mitigate their risk exposure through financial intermediation costs.

Table 5: Effect of Cost of Financial Intermediation and Competition on Bank Risk

Variable Name	Model I	Model II	Comp = Boone Indicator		Comp = Lerner Index	
			Model III	Model IV	Model V	Model VI
RNPL (-1)	0.7821*** (0.005)	0.7636*** (0.006)	0.7995*** (0.005)	0.8004*** (0.004)	0.8159*** (0.004)	0.8066*** (0.004)
CoFI1	-0.1038** (0.047)	-0.7323*** (0.073)	-0.4860*** (0.052)	-0.2152*** (0.035)	-0.3844*** (0.046)	-3.7881*** (0.3829)
$CoFI1^2$		19.1197*** (2.468)				
Inflection Point		0.01915				
Comp			-0.0115*** (0.0008)		0.7268*** (0.0308)	
$Comp^2$			0.0012*** (0.00008)		-0.6118*** (0.024)	
Inflection Point			4.7916		0.5939	
Comp × CoFI1				-0.1244*** (0.015)		11.06143*** (1.221)
$Comp^2$ × CoFI1				0.0118*** (0.001)		-8.14545*** (0.906)
ETA	-0.0449*** (0.011)	-0.0602*** (0.013)	-0.0515*** (0.017)	-0.0407** (0.016)	-0.0353*** (0.013)	-0.0379*** (0.013)
ID	0.9983*** (0.0633)	1.0684*** (0.079)	0.1876*** (0.041)	0.1998*** (0.039)	0.1006*** (0.0303)	0.1366*** (0.03)
Size	-0.0035*** (0.0006)	-0.0033*** (0.0007)	-0.0043*** (0.0004)	-0.0050*** (0.0003)	-0.0037*** (0.0005)	-0.0045*** (0.0004)
ROA	-0.0241*** (0.0002)	-0.0243*** (0.0003)	-0.0160*** (0.0001)	-0.0168*** (0.0001)	-0.0162*** (0.0002)	-0.0169*** (0.0002)
LTD	-0.018*** (0.002)	-0.0118*** (0.002)	-0.0189*** (0.003)	-0.0201*** (0.003)	-0.0165*** (0.002)	-0.0211*** (0.003)
BSD	-0.0002*** (0.00008)	-0.0004*** (0.0001)	-0.0026*** (0.0002)	0.0007*** (0.00009)	-0.0022*** (0.0001)	-0.0006*** (0.00007)
GDP	0.0062*** (0.0002)	0.0065*** (0.0003)	0.0085*** (0.0004)	0.0062*** (0.0002)	-0.0069*** (0.0005)	0.0057*** (0.0002)
Inflation	-0.0002*** (0.0001)	-0.0008*** (0.0002)	-0.00001 (0.0001)	-0.0002** (0.0001)	-0.0036*** (0.0002)	-0.0011*** (0.0001)
Constant	0.0565*** (0.012)	0.0566*** (0.015)	-0.0533*** (0.018)	0.0461*** (0.009)	0.0620*** (0.017)	0.0539*** (0.007)
Hansen test (*p*-value)	0.210	0.209	0.221	0.178	0.247	0.207
AR (1) (*p*-value)	0.018	0.011	0.011	0.015	0.015	0.016
AR (2) (*p*-value)	0.658	0.672	0.506	0.609	0.683	0.631
Observations	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is risk, which is calculated as the ratio of non-performing loan to total loan. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond order 1 and 2 are asymptotically N (0,1).

Table 6: Effect of Cost of Financial Intermediation and Competition on Bank Risk

Variable Name	CI	C II	C III	C IV	C V	C VI	C VII	C VIII	C IX
RNPL (-1)	0.7677*** (0.005)	0.7717*** (0.004)	0.7765*** (0.003)	0.7695*** (0.003)	0.7774*** (0.003)	0.7783*** (0.004)	0.7706*** (0.003)	0.7773*** (0.003)	0.7787*** (0.003)
CoFI1				-0.2046*** (0.031)	-0.2493*** (0.03)	-0.2394*** (0.038)	-0.1903*** (0.04)	-0.2828*** (0.027)	-0.2459*** (0.033)
High CoFI1	0.0308*** (0.003)								
Avg CoFI1		-0.005*** (0.0007)							
Low CoFI1			0.0038*** (0.001)						
High Comp				0.0087*** (0.0008)					
Avg Comp					-0.0029*** (0.0003)				
Low Com						-0.0015*** (0.0004)			
High Comp × CoFI1							0.1841*** (0.056)		
Avg Comp × CoFI1								-0.0787*** (0.023)	
Low Comp × CoFI1									0.0504* (0.025)
All Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.0667*** (0.013)	0.0686*** (0.011)	0.0692*** (0.01)	0.126*** (0.011)	0.083*** (0.009)	0.0811*** (0.008)	0.0752*** (0.013)	0.0769*** (0.009)	0.0757*** (0.009)
Hansen test (*p*-value)	0.315	0.190	0.190	0.202	0.197	0.213	0.157	0.197	0.210
AR (1) (*p*-value)	0.012	0.016	0.017	0.018	0.018	0.019	0.018	0.018	0.019
AR (2) (*p*-value)	0.683	0.609	0.604	0.673	0.647	0.623	0.640	0.631	0.622
Observations	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is risk, which is calculated as the ratio of non-performing loan to total loan. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond order 1 and 2 are asymptotically N (0,1).

4.3 Effect of Bank Risk and Market Competition on the CoFI

Table 7 demonstrates how bank risk and market competition affect CoFI. The regression coefficient of the lag-dependent variable is significant, inferring that the previous year's effect transfers to the prevailing year and the risk ratio is consistent. The inverse connection between risk (NPL) and the CoFI in Model I implies that the high risk-taking propensity of banks has a negative impact on the CoFI. This finding is aligned with the findings of Tarus et al. (2012) and Mia (2023).

The variable of capital has a positive and statistically significant effect on CoFI, implying that financial institutions with a more excellent capital base have a heightened ability to lend and extend credit to borrowers. This superior lending capacity, in turn, leads to a rise in net interest income, ultimately driving growth in CoFI. This result is aligned with the results of Shabir et al. (2023). Income diversification shows a significant negative relationship with CoFI, which implies that increasing nonconventional (noninterest income) funding sources decreases the bank's margin. This result is harmonized with Rahman et al. (2018). CoFI is positively impacted by size, indicating that larger banks tend to have cost-efficient operations due to economies of scale. As a result, they can achieve higher CoFI. This result is aligned with Gupta et al. (2021) and incongruence with Gelos (2009). The coefficient value of operating expenses is positive, meaning banks with higher operating costs charge higher margins. This outcome provides strong support for the research of Maudos and Fernández de Guevara (2004), who expanded the original dealership model of Ho and Saunder (1981) by addressing Lerner (1981) criticism and incorporating the operating cost. The coefficient value of liquidity is positive, suggesting that banks with higher liquidity are more confident in their abilities to invest their funds effectively and generate more CoFI. This outcome aligns with Peria and Mody (2004).

Industry-specific variable BSD shows a significant positive relation, which states that with the development of the banking industry, banks' CoFI is also increasing. However, this finding contradicts the findings of Gupta et al. (2021). The macroeconomic variable GDP has a significant positive effect on CoFI, suggesting that banks can generate more CoFI by providing more loans to borrowers with economic development. This finding supports the findings of the Shabir et al. (2023). Additionally, inflation has been shown to correlate positively with CoFI, as banks tend to charge higher interest rates during times of inflationary pressure. This corresponds with the finding of Entrop et al. (2015).

Table 7 presents the empirical results of Equation (5) to Equation (7), which show the combined effect of risk and competition on CoFI. Models II to VI showcase the linear and non-linear consequences of risk and competition on CoFI. Model II represents the non-linear effect of risk, Model III and Model V demonstrate the linear and non-linear effect of competition on CoFI, and Model IV.

Model II of Table 7 reveals a significant U-shaped correlation between risk and CoFI. To evaluate the nature of the association between the variables in quadratic equations, we estimate the inflection of each equation and contrast it with the data distribution. The equation of Model II has an inflection point at 0.3376, which is observed at approximately the 31st percentile of the RNPL distribution. This inflection point suggests an inverse relationship between bank risk and COFI below the point of inflection. However, above this point, the correlation becomes positive. Additionally, we examined possible nonlinear relationships between risk and CoFI, dividing bank risk into three categories: high, average, and low. As in columns I, II, and III of Table 8, banks with high and low risk tend to generate more CoFI. On the other hand, banks with an average risk level demonstrate a lower CoFI generation and display an inverse correlation with bank risk-taking. Hence, this suggests that risk-takers or risk-averse banks can generate more CoFI than those with average risk levels.

Table 7: Effect of Bank Risk and Competition on the Cost of Financial Intermediation

Variable Name	Model I	Model II	Comp = Boone Indicator		Comp = Lerner Index	
			Model III	Model IV	Model V	Model VI
CoFI1 (-1)	0.6396*** (0.033)	0.6537*** (0.035)	0.6711*** (0.028)	0.6807*** (0.036)	0.6064*** (0.024)	0.6392*** (0.041)
RNPL	-0.0175*** (0.002)	-0.0516*** (0.013)	-0.0094*** (0.002)	-0.0162*** (0.003)	-0.0095*** (0.003)	-0.0149* (0.008)
$RNPL^2$		0.0764*** (0.023)				
Inflection Point		0.3376				
Comp			-0.0011*** (0.0002)		0.1434*** (0.018)	
$Comp^2$			0.0001*** (0.00002)		-0.1101*** (0.013)	
Inflection Point			5.5		0.6512	
Comp × RNPL				-0.0037* (0.002)		0.0275** (0.011)
$Comp^2$ × RNPL				0.0007*** (0.0002)		-0.0378** (0.019)
ETA	0.0239*** (0.006)	0.024*** (0.007)	0.0243*** (0.007)	0.0235*** (0.006)	0.0268*** (0.007)	0.0214*** (0.007)
ID	-0.3570*** (0.042)	-0.3432*** (0.056)	-0.3566*** (0.047)	-0.3347*** (0.039)	-0.4213*** (0.05)	-0.3859*** (0.05)
Size	0.0019*** (0.0005)	0.0025*** (0.0006)	0.0023*** (0.0006)	0.002*** (0.0005)	0.0024*** (0.0006)	0.0017** (0.0007)
NIETA	0.0159*** (0.002)	0.0152*** (0.003)	0.0161*** (0.003)	0.0157*** (0.002)	0.0182*** (0.002)	0.0174*** (0.003)
LTD	0.0041** (0.001)	0.0013 (0.001)	0.0043*** (0.001)	0.0025* (0.001)	0.0062*** (0.0001)	0.0054** (0.002)
BSD	0.0002*** (0.00007)	0.0002*** (0.00006)	0.0003*** (0.0001)	0.0001 (0.00009)	0.0002** (0.0001)	0.0002*** (0.0001)
GDP	0.0025*** (0.0001)	0.0026*** (0.0001)	0.0025*** (0.0001)	0.0022*** (0.0001)	0.0016*** (0.0001)	0.0025*** (0.0001)
Inflation	0.0011*** (0.0001)	0.0011*** (0.0002)	0.0012*** (0.0001)	0.0011*** (0.0001)	0.0006*** (0.0001)	0.0012*** (0.0002)
Constant	-0.0588*** (0.012)	-0.0645*** (0.011)	-0.0713*** (0.013)	-0.0555*** (0.011)	-0.1066*** (0.014)	-0.0627*** (0.013)
Hansen test (*p*-value)	0.259	0.226	0.157	0.208	0.206	0234
AR (1) (*p*-value)	0.088	.085	0.096	0.084	0.074	0.077
AR (2) (*p*-value)	0.610	0.639	0.574	0.590	0.461	0.682
Observations	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is CoFI1, calculated as the ratio of net interest income to total earning assets. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond orders 1 and 2 are asymptotically N (0,1).

Table 8: Effect of Bank Risk and Competition on the Cost of Financial Intermediation

Variable Name	CI	C II	C III	C IV	C V	C VI	C VII	C VIII	C IX
CoFI1 (-1)	0.6399*** (0.041)	0.6155*** (0.042)	0.6083*** (0.043)	0.6786*** (0.039)	0.6171*** (0.04)	0.681*** (0.041)	0.6917*** (0.034)	0.6253*** (0.034)	0.7026*** (0.031)
RNPL				-0.0101*** (0.002)	-0.0123*** (0.003)	-0.0085*** (0.002)	-0.0085** (0.004)	-0.0157*** (0.002)	-0.0203*** (0.002)
High Risk	0.0037** (0.001)								
Avg Risk		-0.0013* (0.0007)							
Low Risk			0.0025** (0.001)						
High Comp				0.0007*** (0.0002)					
Avg Comp					0.0015*** (0.0003)				
Low Com						-0.0019*** (0.0002)			
High Comp × RNPL							0.0111*** (0.001)		
Avg Comp × RNPL								0.0091*** (0.002)	
Low Comp × RNPL									-0.0195*** (0.002)
All Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0601*** (0.012)	-0.0662*** (0.011)	-0.0735*** (0.01)	-0.0533*** (0.013)	-0.0696*** (0.013)	-0.0554*** (0.012)	-0.0485*** (0.011)	-0.0635*** (0.012)	-0.0498*** (0.01)
Hansen test (*p*-value)	0.187	0.233	0.219	0.232	0.204	0.214	0.239	0.215	0.218
AR (1) (*p*-value)	0.082	0.081	0.079	0.091	0.085	0.093	0.099	0.083	0.095
AR (2) (*p*-value)	0.655	0.712	0.738	0.555	0.853	0.628	0.541	0.616	0.471
Observations	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is CoFI1, calculated as the ratio of net interest income to total earning assets. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond orders 1 and 2 are asymptotically N (0,1).

Based on Model III, there is a significant U-shaped relationship between competition (measured by inverse BI) and CoFI. Model V reveals that market power (measured by the LI) has a significant inverse U-shaped relationship with CoFI. In Model III, the inflection point is 5.5, approximately the 74th percentile of the BI distribution, meaning that the relationship between competition and CoFI is negative up to the inflection point. However, once the inflection point is surpassed, the relationship becomes positive. Moreover, in Model V, the inflection point is 0.6512, around the 82% percentile of the LI distribution, meaning that the rest of the 18% of the data lies above the inflection point. These interactions highlight that the impact of competition on the CoFI is shaped like a U. It is apparent from columns IV, V, and VI of Table 8 that highly competitive and average-competitive banks can generate more CoFI, while low-competitive banks can generate less CoFI. Therefore, we can conclude that our results reject (yet also support) the SCP (Structure-Conduct-Performance) hypothesis for Bangladeshi banks.

In Model IV, the interactions between RNPL and the inverse BI and between RNPL and the squared term of the inverse BI show that the effect of RNPL on the CoFI is a U-shape as a function of the BI. Again, in Model VI, the interactions between RNPL and the LI and between RNPL and the squared term of the LI show that the effect of RNPL on bank risk-taking is an inverse U-shape as a function of the LI. These interactions highlight the impact of risk on CoFI, which is shaped like a U as competition levels fluctuate. The positive coefficient of the interaction between the high competition dummy and RNPL, the positive coefficient of the interaction between the average competition dummy and RNPL, and the negative coefficient value of the association between the low competition dummy and RNPL in columns VII to IX of Table 8 support this result. These findings indicate that in the case of highly competitive or average-competitive banks, risk positively affects CoFI.

In contrast, in the case of low-competitive banks, the impact of RNPL on CoFI taking is negative. The findings suggest that high or average-competitive banks can adapt to increased risk by increasing CoFI. However, low-competitive banks face constraints in responding effectively to heightened risk. These findings indicate that highly competitive and average-competitive banks can adjust to greater risk by raising CoFI. However, low-competitive banks encounter challenges in effectively responding to heightened risk. These results highlight the need to consider market competition when examining the relationship between CoFI and risk.

4.4 Robustness checks

To confirm the precision of our primary conclusions, we conducted rigorous assessments by the study of various scholars, including Berger et al. (2023), Liu et al. (2020), and Rahman et al. (2017), by utilizing alternative specifications of the dependent variables to ensure the accuracy of our main findings. We used the Loan Loss Provision to Total Loan (LLP) ratio as an alternative proxy of bank risk-taking. Furthermore, we use the net interest income to average total assets (CoFI2) as an alternative proxy of CoFI. We re-estimated equations (4) to (7) using these alternative proxies and presented the results in Tables 9-12. The impact of CoFI and market competition on bank risk is showcased in Table 9, while the effects of different CoFI and competition categories on bank risk are displayed in Table 10.

Table 11 demonstrates the interplay between bank risk, market competition, and CoFI. Finally, Table 12 presents the effects of varying risk and competition categories on CoFI. The results in these tables support our main findings reported in Tables 5-8.

Table 9: Effect of Cost of Financial Intermediation and Competition on Bank Risk

Variable Name	Model I	Model II	Comp = Boone Indicator		Comp = Lerner Index	
			Model III	Model IV	Model V	Model VI
RLLP (-1)	0.7386*** (0.002)	0.7076*** (0.002)	0.7251*** (0.004)	0.7131*** (0.004)	0.7199*** (0.003)	0.7174*** (0.002)
CoFI1	-0.1738*** (0.008)	-0.5397*** (0.008)	-0.0599*** (0.009)	0.0523*** (0.013)	-0.1592*** (0.018)	-3.0813*** (0.158)
$CoFI1^2$		8.3412*** (0.639)				
Inflection Point		0.0323				
Comp			-0.0014** (0.0006)		0.4206*** (0.023)	
$Comp^2$			0.0002*** (0.00006)		-0.3424*** (0.02)	
Inflection Point			3.5		0.6141	
Comp × CoFI1				-0.171*** (0.011)		9.1426*** (0.511)
$Comp^2$ × CoFI1				0.018*** (0.001)		-6.4026*** (0.395)
ETA	-0.0646*** (0.003)	-0.0776*** (0.003)	-0.0706*** (0.004)	-0.0739*** (0.004)	-0.0791*** (0.004)	-0.0739*** (0.004)
ID	0.1472*** (0.021)	0.1396*** (0.018)	0.2247*** (0.025)	0.1806*** (0.022)	0.1415*** (0.022)	0.1595*** (0.019)
Size	-0.0017*** (0.0001)	-0.0019*** (0.00009)	-0.0025*** (0.0002)	-0.0021*** (0.0001)	0.0031*** (0.0001)	-0.0022*** (0.0001)
ROA	-0.0108*** (0.0001)	-0.0109*** (0.0001)	-0.012*** (0.0001)	-0.0115*** (0.0001)	-0.0113*** (0.0001)	-0.0116*** (0.0001)
LTD	-0.01*** (0.0008)	-0.006*** (0.0006)	-0.0116*** (0.001)	-0.0119*** (0.0006)	-0.0104*** (0.0008)	-0.014*** (0.0007)
BSD	-0.0003*** (0.00004)	-0.0003*** (0.00005)	0.0001 (0.0001)	-0.001*** (0.00006)	-0.0004** (0.0001)	-0.0009*** (0.00005)
GDP	0.0013*** (0.00008)	0.0013*** (0.0001)	0.0014*** (0.0002)	0.002*** (0.0001)	-0.0038*** (0.0006)	0.0024*** (0.0001)
Inflation	-0.0009*** (0.00008)	-0.0008*** (0.000)	-0.0005*** (0.00008)	-0.0006*** (0.00008)	-0.0012*** (0.0001)	-0.0003*** (0.0001)
Constant	-0.0284*** (0.002)	-0.0341*** (0.00008)	-0.0315*** (0.009)	-0.0686*** (0.004)	-0.0873*** (0.011)	-0.0617*** (0.003)
Hansen test (*p*-value)	0.272	0.179	0.305	0.300	0.378	0.276
AR (1) (*p*-value)	0.092	0.093	0.096	0.094	0.082	0.097
AR (2) (*p*-value)	0.373	0.361	0.364	0.361	0.391	0.392
Observations	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is risk, which is calculated as the ratio of loan-loss provision to total loan. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond orders 1 and 2 are asymptotically N (0,1).

Table 10: Effect of Cost of Financial Intermediation and Competition on Bank Risk

Variable Name	CI	C II	C III	C IV	C V	C VI	C VII	C VIII	C IX
RLLP (-1)	0.7276*** (0.002)	0.7267*** (0.002)	0.7489*** (0.004)	0.7528*** (0.003)	0.744*** (0.003)	0.7426*** (0.004)	0.7277*** (0.003)	0.7385*** (0.004)	0.7412*** (0.004)
CoFI1				-0.2529*** (0.012)	-0.1396*** (0.011)	-0.0968*** (0.014)	-0.4264*** (0.011)	-0.1679*** (0.008)	-0.1844*** (0.013)
High CoFI	0.0063*** (0.0006)								
Avg CoFI		-0.0052*** (0.0003)							
Low CoFI			-0.0064** (0.0007)						
High Comp				0.0122*** (0.0002)					
Avg Comp					-0.0032*** (0.0001)				
Low Com						-0.00355*** (0.0001)			
High Comp × CoFI							0.2559*** (0.009)		
Avg Comp × CoFI								-0.0491** (0.011)	
Low Comp × CoFI									0.3745*** (0.016)
All Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0337*** (0.003)	-0.0321*** (0.005)	-0.0237*** (0.003)	-0.1157*** (0.004)	-0.0159*** (0.002)	-0.0336*** (0.003)	-0.0648*** (0.004)	-0.0313*** (0.004)	-0.0496*** (0.004)
Hansen test (p-value)	0.282	0.221	0.239	0.201	0.221	0.294	0.309	0.216	0.228
AR (1) (*p*-value)	0.011	0.008	0.011	0.012	0.008	0.013	0.012	0.011	0.018
AR (2) (*p*-value)	0.359	0.358	0.377	0.455	0.376	0.382	0.408	0.372	0.404
Observations	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is risk, which is calculated as the ratio of loan loss provision to total loan. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond order 1 and 2 are asymptotically N (0,1).

Table 11: Effect of Bank Risk and Competition on the Cost of Financial Intermediation

Variable Name	**Model I**	**Model II**	**Comp = Boone Indicator**		**Comp = Lerner Index**	
			Model III	Model IV	Model V	Model VI
CoFI2 (-1)	0.6051*** (0.029)	0.6159*** (0.042)	0.6528*** (0.028)	0.6817*** (0.033)	0.6111*** (0.028)	0.6482*** (0.034)
RNPL	-0.0215*** (0.003)	-0.0577*** (0.011)	-0.0109*** (0.002)	-0.0153*** (0.002)	-0.0089*** (0.002)	-0.0187*** (0.005)
$RNPL^2$		0.0861*** (0.018)				
Inflection Point		0.3351				
Comp			-0.0009*** (0.0001)		0.1058*** (0.015)	
$Comp^2$			0.0001*** (0.00001)		-0.0793*** (0.011)	
Inflection Point			4.5		0.6671	
Comp × RNPL				-0.0028* (0.001)		0.0272*** (0.008)
$Comp^2$ × RNPL				0.0006*** (0.0002)		-0.0216* (0.012)
ETA	0.0189*** (0.005)	0.0234*** (0.006)	0.0211*** (0.005)	0.0198*** (0.005)	0.0246*** (0.006)	0.0214*** (0.005)
ID	-0.2968*** (0.041)	-0.3097*** (0.054)	-0.3067*** (0.04)	-0.2851*** (0.036)	-0.3398*** (0.045)	-0.3260*** (0.041)
Size	0.0015*** (0.0004)	0.0023*** (0.0005)	0.0016*** (0.0005)	0.0014*** (0.0004)	0.0019*** (0.0005)	0.0017*** (0.0004)
NIETA	0.0126*** (0.002)	0.0132*** (0.002)	0.0129*** (0.002)	0.0121*** (0.002)	0.0154*** (0.002)	0.0147*** (0.002)
LTD	0.0034** (0.001)	-0.0001 (0.001)	0.0036* (0.001)	0.0025* (0.001)	0.0065*** (0.001)	0.004** (0.001)
BSD	0.0002*** (0.00006)	0.0002*** (0.00005)	0.0003*** (0.00009)	0.00009 (0.00008)	0.0002** (0.0001)	0.0002** (0.00007)
GDP	0.0022*** (0.00009)	0.0023*** (0.0001)	0.0022*** (0.0001)	0.002*** (0.0001)	0.0017*** (0.0002)	0.0021*** (0.0001)
Inflation	0.0009*** (0.0001)	0.0008*** (0.0001)	0.0009*** (0.0001)	0.001*** (0.0001)	0.0004*** (0.0001)	0.001*** (0.0001)
Constant	-0.0475*** (0.009)	-0.0534*** (0.011)	-0.0543*** (0.011)	-0.0425*** (0.009)	-0.0881*** (0.012)	-0.053*** (0.009)
Hansen test (*p*-value)	0.246	0.270	0.184	0.202	0.297	0.237
AR (1) (*p*-value)	0.038	0.031	0.044	0.036	0.024	0.033
AR (2) (*p*-value)	0.569	0.429	0.456	0.494	0.479	0.452
Observations	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is CoFI2, calculated as the ratio of net interest income to total average assets. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond orders 1 and 2 are asymptotically N (0,1).

Table 12: Effect of Bank Risk and Competition on the Cost of Financial Intermediation

Variable Name	CI	C II	C III	C IV	C V	C VI	C VII	C VIII	C IX
CoFI2 (-1)	0.5861*** (0.045)	0.5853*** (0.051)	0.5664*** (0.051)	0.6766*** (0.035)	0.5987*** (0.04)	0.7157*** (0.04)	0.6439*** (0.027)	0.5748*** (0.032)	0.6692*** (0.032)
RNPL				-0.0135*** (0.003)	-0.0167*** (0.003)	-0.0142*** (0.003)	-0.0122*** (0.003)	-0.0208*** (0.003)	-0.0237*** (0.002)
High Risk	0.0056*** (0.001)								
Avg Risk		-0.0022*** (0.0007)							
Low Risk			0.0018 (0.001)						
High Comp				0.0007*** (0.0002)					
Avg Comp					0.0013*** (0.0002)				
Low Com						-0.0019*** (0.0002)			
High Comp × RNPL							0.0178*** (0.002)		
Avg Comp × RNPL								0.0099*** (0.001)	
Low Comp × RNPL									-0.0231*** (0.003)
All Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0505*** (0.009)	-0.0614*** (0.009)	-0.0627*** (0.009)	-0.0395*** (0.011)	-0.0545*** (0.011)	-0.0364*** (0.008)	-0.0389*** (0.006)	-0.0539*** (0.009)	-0.0455*** (0.007)
Hansen test (*p*-value)	0.174	0.189	0.231	0.212	0.193	0.211	0.131	0.162	0.160
AR (1) (*p*-value)	0.023	0.021	0.023	0.047	0.035	0.052	0.037	0.034	0.033
AR (2) (*p*-value)	0.478	0.437	0.462	0.423	0.416	0.553	0.495	0.530	0.410
Observations	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**	**420**

Notes: The dependent variable is CoFI2, calculated as the ratio of net interest income to total average assets. Standard errors in parentheses. ***, **, * denotes the significance level at the corresponding 1%, 5%, and 10% level. The p-value of the Hansen test is referred to as J statistics. Tests for first-order (second-order) correlation using Arellano-Bond orders 1 and 2 are asymptotically N (0,1).

5. Conclusion

The study investigated the effect of competition on the association between bank risk and the cost of financial intermediation using the sample banks' annual data from 2010 to 2021. The dependent variables are risk and the CoFI, while the independent variables are market competition, banking sector development, GDP, inflation, capital, bank size, profitability, liquidity, income diversification, and operating costs. The study uses the Boone indicator, a non-structural measure of market structure, as a proxy for Competition because BI is based on market dynamism rather than static analysis. To make the BI directly proportional to the competition, we take the inverse of the BI. We dichotomized the competition, risk, and CoFI variables into three categories—high, average, and low—to identify the potential non-linearity effects. We opt for the two-step system GMM for regression analysis due to the nature of the data, and, as indicated by the pre-diagnostic tests. We further confirm their validity through a robustness check using different specifications for the dependent variables.

Our findings indicate the bidirectional non-linear association between risk and CoFI, which suggests that banks with low or high CoFI levels may be at greater risk than those with average CoFI levels and indicates that risk-takers or risk-averse banks can generate more CoFI than those with average risk levels. These findings also suggest an optimal risk level where CoFI can be maximized and an optimal CoFI level where risk can be minimized. Our specifications do not provide any evidence of how to define optimal risk level or COFI level. Our findings specify that the non-linearity of the impact of competition on risk-taking supports competition stability and the competition fragility theory. Both high and low-competitive banks are, on average, more risk-takers than banks undergoing average competition. The average competitive banks with larger CoFI can mitigate their risk exposures more effectively than those that are highly or low competitive. Again, the non-linearity of the effect of competition on the cost of financial intermediation supports (yet also rejects) the Structure-Conduct-Performance (SCP) hypothesis. Both high and average-competitive banks are, on average, generating more CoFI than banks experiencing low competition. Again, highly or average competitive banks can adjust to greater risk by raising their CoFI. However, low-competitive banks encounter challenges in effectively responding to heightened risk. In this study, we investigate the effects of competition on the risk-CoFI nexus; however, our specifications do not provide any evidence as to why different competitive situations of banks in the market behave differently in this nexus.

Furthermore, according to this study, Bangladeshi banks that are highly competitive or low-competitive take greater risks. Conversely, highly and average competitive banks typically produce higher CoFI. As a result, considering all factors, this study proposes that banks with moderate competition exhibit strong risk management and possess the ability to generate favorable CoFI. The consideration of the cost of financial services as a factor affecting their quality aligns with cost-benefit analysis principles. Understanding the costs involved for clients is crucial for assessing the

overall value and attractiveness of financial products and services. So, regulators must be vigilant in establishing risk exposure levels and provide structures for limiting margin levels to secure the financial stability and soundness of the national banking and economic systems. The regulators should also monitor the flow of information in the market and the supply-side behavior in the loan market. Banks should be more cautious in charging margins by their specialization, considering market segmentation relying on borrower capabilities and quality and the condition of market competition.

In conclusion, this paper analyzes single-country exposures to investigate the impact of competition on the correlation between risk and CoFI, ignoring cross-country assessment and the global epidemic's effect on this nexus. Future analyses can address this limitation based on data availability of foreign banks and include cross-country data.

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