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Article

The Efficacy of Risk-based Supervision in Enhancing Bank Stability and Profitability: A Projection-based Scenario Analysis

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Abstract

This study aims to examine the opportunities to enhance bank stability and profitability following the implementation of the risk-based supervision (RBS), which is a regulatory approach that prioritizes allocating oversight resources based on each bank's risk profile, applying a structured, process-driven methodology to identify and quantify not only the risks faced by a bank but also the quality of its risk management and internal controls. This study adopts both qualitative and quantitative approaches. Qualitative data from expert interviews, focus group discussions, and stakeholder interviews are used to project financial indicators for individual banks, prioritizing their historical trends and considering RBS intervention. We conducted a panel data analysis of historical and projected data for Bangladesh's commercial banks to examine the efficacy of RBS in enhancing bank stability and profitability. We have projected our data considering conservative, base, and optimistic scenarios. In each scenario, we incorporate both fixed and random effects in our analysis. Our analysis of historical and projected data for Bangladesh's commercial banks indicates improved bank stability resulting from the successful implementation of RBS across all scenarios. Effective supervision takes proactive measures to maintain asset quality, prevent capital erosion, reduce non-performing loans, and ultimately ensure bank stability. However, the scenario analysis of our data also indicates that RBS adversely affects banks' profitability due to the possible costs of developing IT infrastructure, implementing enhanced management control systems, and hiring skilled, well-trained employees. This study contributes to the banking literature by quantifying the efficacy of risk-based over rule-based bank supervision, facilitating strategic decision-making by policymakers, regulators, and bank management to achieve maximum output from RBS implementation.

Keywords

Risk-based supervision, Rule-based supervision, Banking regulation, Bank stability, Profitability

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1. Introduction

Risk-based supervision (RBS) is a regulatory approach that prioritizes monitoring and managing financial institutions based on their risk profiles [1]. Unlike traditional supervision methods that apply uniform oversight, RBS focuses on identifying, assessing, and mitigating risks specific to each institution [2]. The RBS approach allows regulators to prioritize the areas of utmost concern in bank supervision and risk management, and to apply targeted interventions to ensure financial stability. RBS has the potential to mitigate systemic risks and foster a more resilient financial system by improving financial stability, regulatory efficiency, and investor confidence [3].

RBS was first introduced in the United States in the late 1980s, following the increasing complexity of financial institutions, which became a significant concern in the mid-1980s [2]. Later, the global financial crisis (2007-2009) served as a wake-up call, exposing the limitations of traditional one-size-fits-all approaches to supervision. The vulnerabilities in the system, such as a lack of effective risk assessment, inadequate capital requirements, and limited supervisory oversight, were revealed by the crisis. In that situation, the key role was played by i) Basel Committee on Banking Supervision (BCBS): Basel Accords III, adopted in 2010, significantly strengthened capital requirements and introduced new liquidity rules for banks, explicitly reflecting their risk profiles; ii) International Monetary Fund (IMF) and Financial Stability Board (FSB): promoted best practices and standards for RBS implementation; iii) Regulators' focus on systemic risk: regulators shifted their focus from individual institutions to the broader financial system, identifying and addressing interconnected risks [4-6].

Although RBS is considered an effective supervisory technique for addressing systemic risk worldwide, there is very limited research assessing its impact. Existing research on RBS is primarily descriptive. Quantitative research on RBS can accurately examine its impact on bank stability and profitability, helping policymakers, regulators, and bank management make strategic decisions. Our work aims to fill a gap in the existing literature.

To ensure a forward-looking, risk-sensitive, and efficient supervisory system aligned with international best practices, Bangladesh Bank, the country's central bank, has implemented RBS as a supervisory approach for the banking sector in January 2026. This paper examines the opportunities to enhance bank stability and profitability following the implementation of the RBS in Bangladesh.

The panel data analysis of 78 quarters (19.5 years), including 39 historical and 39 projected quarters of commercial bank data in Bangladesh, indicates enhanced bank stability and deteriorating bank profitability as a consequence of RBS. This paper contributes to the banking literature by quantifying the efficacy of risk-based over rule-based bank supervision.

2. Risk-based Supervision in Bangladesh

After the global financial crisis in 2008, many countries adopted RBS for the financial sector. Bangladesh Bank also recognized the need to align with international standards to strengthen governance and resilience in the banking sector [7]. Bangladesh's banking industry has been plagued by a higher level of non-performing loans as a percentage of total loans, weak private-sector credit growth due to stressed political and economic conditions, and a weak governance structure across regulatory oversight and bank internal management [8]. To ensure qualitative transformation in the banking industry, the Bangladesh Bank has developed a comprehensive RBS strategy. After three phases of survey and assessment, Bangladesh Bank officially adopted RBS in the banking sector on January 4, 2026.

In confirmation with the regulatory approach of the RBS, that prioritizes the allocation of oversight resources according to each institution's risk profile, applying a structured, process-driven methodology to identify and quantify not only the risks faced by a bank but also the quality of its risk management and internal controls, the purposes of RBS in Bangladesh are: i) shifting from rule-based to risk-based, ii) single point supervision, iii) dynamic & forward-looking, and iv) avoiding 'one size fits for all'.

In the Bangladesh Bank risk matrix model, several risks have been considered based on RBS practices at central banks in developed and emerging markets, including Bank Negara Malaysia, the Monetary Authority of Singapore, and the Bank of Thailand. In the Bangladesh Bank Risk model, there are five inherent risks: credit risk, market risk, operational risk, legal and regulatory risk, and strategic risk. The model also considers three composite risks: earnings, capital, and liquidity. Moreover, there are three risks in institutional assessment: cultural, technological, and money laundering & terrorist financing.

3. Literature Review

RBS is a supervisory framework that endorses a judgment-driven, assessment-based approach rather than a checklist-based one. RBS originated mainly from the Basel Core Principles (BCP), which emphasized its importance in assuring financial stability in the context of a fast-paced, dynamic economic and banking operations landscape. The BCBS developed a consultative document on sound bank supervision and regulation as a global standard, covering several thematic topics: financial risks, operational resilience, systemic risk, macroprudential supervision, climate-related financial risk, digitalization of financial intermediation, and risk management practices. In total, 29 core principles are

categorized into two groups: i) power, responsibilities, and functions of supervisors (principles no. 1-13), ii) prudential regulations and requirements for banks (principles no. 14-29) [9].

“A bank’s risk management framework should take an integrated bank-wide perspective of its risk exposure, encompassing individual business lines and business units” [10]. In conducting supervision, “supervisors consider the risk profile and systemic importance of individual banks” [10].

World Bank Group developed a guidance note for RBS to protect financial consumer protection, which includes ten key elements - six context factors (current data position, legal and regulatory foundation, market characteristics, overarching supervisory approach, organizational setting, staff considerations, and current data position) and four core components (data collection & analysis, risk indicators, risk assessment framework, and risk-based monitoring & supervision activities) [11].

Worldwide, RBS reflects the principles of effective financial risk management, requiring supervisors to examine internal risk controls cumulatively. In developed countries like the United States (U.S.), RBS is now an essential part of banking regulations, replacing indiscriminate oversight with targeted measures based on banks' scale, complexity, and susceptibility to fundamental risks: credit, market, operational, and liquidity risks [12]. Empirical evidence from the U.S. shows that supervision has a dynamic role in effective bank regulation, particularly by reducing non-performing loans and volatility in adverse banking scenarios. In examining the impact of supervision on bank risk-taking and performance, it was found that banks receiving greater supervisory attention maintain less-risky loan portfolios, exhibit lower volatility, and demonstrate reduced sensitivity to industry downturns, thereby maintaining overall growth and profitability [13].

Studies have repeatedly shown that RBS, being more efficient, is associated with improved banking efficiency and performance, serving as proxies for financial stability, under the assumption that stable institutions are better able to withstand disturbances. A sample of 22 European countries’ banking systems between 2000 and 2008 suggests that increased supervisory powers, along with improved capital management, lead to greater efficiency within institutions [14].

A bank's increased risk-taking needs to be offset by higher capital to ensure bank stability [15]. In addition, studies found that effective supervision and market discipline requirements function as complementary mechanisms to reduce bank fragility. The findings also revealed an inverted U-shaped relationship between on-site audits and bank risk, and a negative linear relationship between sanctions and risk [16].

Moreover, during the turbulent period of the Greek financial crisis (2009-2018), supervision proved instrumental in many ways, including crisis management, liquidity management, preventing further deterioration of non-performing loans, and achieving sustainability [17]. Their analysis of Greece’s four systemic banks from 2015 to 2024 indicates that enhanced supervision contributed to greater resilience and regulatory compliance.

Disproportionate credit growth, an expansive banking sector, elevated inflation, current account deficits, bank inefficiency, and high levels of non-performing loans increase the likelihood of banking instability [18]. In contrast, broad money growth, higher central bank reserves, GDP growth, current account surpluses, and improved bank profitability and capitalization mitigate instability. Moreover, an effective supervision system enables a bank to sustain stable profitability [19].

In existing literature, there are many studies on bank supervision, but very few, especially with RBS. These are mostly either descriptive or survey-based. Although the RBS regime has proven effective for banking supervision worldwide, quantitative research on RBS that can precisely examine its impact on bank stability or profitability is very sparse in the literature. This study aims to fill this gap by quantifying the effectiveness of RBS in facilitating strategic decision-making to maximize the output of its implementation.

4. Theoretical Framework and Hypothesis Development

4.1 Bank Stability and Risk-based Supervision

The theoretical foundation of the beneficial role of RBS on bank stability can be explained in three ways: agency theory, asymmetric information theory, and systemic risk externalities.

i) Agency Theory and Incentive Alignment: Banks face a principal-agent problem, whereby the shareholders (principals) assign decision-making powers to the bank managers (agents). When the two parties' interests are misaligned, the agents may take risks to maximize their gains. In the RBS framework, bank supervisors proactively and regularly monitor the bank's behavior and ensure that it behaves correctly. Moreover, greater supervisory attention reduces risk-taking, as measured by lower earnings volatility and higher capital adequacy ratios among supervised institutions [13].

ii) Asymmetric Information Theory: Information asymmetry among banks, supervisors, and markets makes it difficult to supervise and results in a gradual build-up of opaque risks [20]. RBS has further addressed this problem through risk profiling and stress testing to enhance efficiency and transparency in the banking system. Lower information

asymmetry stabilizes the banking industry, enabling regulators to anticipate looming crises and take action to prevent bank runs.

iii) Systemic Risk & Externalities: Individual risk often spreads through the system, such as contagion effects through interbank lending. RBS prevents this systemic contagion effect by focusing on systemically important banks and providing intensive supervision through tools, such as the Probability Risk and Impact System (PRISM). These methods are based on the theory that systemic risks can be mitigated through effective regulatory mechanisms and high-quality supervisory standards, as outlined by RBS. RBS strengthens the banking and financial system by enhancing supervisory and management practices.

Based on a consolidation of theoretical arguments, the RBS serves as a mechanism that operates synergistically to align regulatory and supervisory activities. Dynamic supervision accounts for risk factors, enabling the model to function more effectively than a static compliance model. The RBS fosters a culture in which risks are mitigated proactively. The model provides banks with a buffer against shocks while giving regulatory authorities time to focus on the high-risk areas. Based on these theoretical underpinnings, RBS's customized, forward-looking supervisory approach is expected to enhance banking stability. This leads us to our hypothesis:

Hypothesis 1: Risk-based Supervision is positively associated with Bank stability.

4.2 Bank Profitability and Risk-based Supervision

Although RBS ensures bank stability through risk identification, risk mitigation, and stronger internal risk governance, it also incurs costs across many areas, including the adoption of advanced data management systems, software upgrades, and the hiring and retention of skilled & trained personnel. Sometimes the transition to RBS requires reevaluating existing portfolios to address emerging market and credit risks, which increase banks' capital requirements and supervisory costs. Smaller banks usually have lower economies of scale, and adopting RBS increases their operational costs and reduces their profitability [21].

RBS entails higher administrative and upfront implementation costs [22]. Due to the adoption of RBS, banks' profitability declines to accommodate various costs.

All these phenomena reflect one of the most fundamental prudential trade-offs: risk-based supervision internalizes the benefits of systemic stability while externalizing the implementation costs for banks. This leads to our second hypothesis:

Hypothesis 2: Risk-Based Supervision is negatively associated with bank profitability.

5. Methods, Data, and Empirical Framework

This study adopts both qualitative and quantitative approaches. As Bangladesh has introduced RBS very recently, qualitative data from expert interviews, focus group discussions, and stakeholder interviews are essential for projecting financial indicators for individual banks, prioritizing their historical trends, and considering RBS intervention. Following the interview guidelines (Table A1 in Appendix 1), we have conducted 3 focus group discussions and semi-structured interviews with selected commercial bank officials (120 persons) from all scheduled commercial banks in Bangladesh. We also conducted 20 expert interviews from the policy-making and supervisory departments of Bangladesh Bank.

At the beginning of each interview, respondents were informed about the purpose of the research. Their participation was voluntary, and all were assured of confidentiality.

The interview data have been processed through NVivo 14. We employed a thematic coding approach to categorize responses under two main dimensions: bank stability and bank profitability. Each dimension derives from three distinct orders (Table A2 in Appendix 2). The information obtained from the interviews and focus group discussions primarily serves as input for our financial projection and theoretical arguments. In our projections, we also considered inputs from RBS-related guidance notes issued by the country's central bank, international practices, and experience of other countries, as mentioned in various documents. Later, we used both historical and projected data in the quantitative analysis.

5.1 Variables and Data

Primarily, we have considered all commercial banks for the study. However, we have to exclude a few banks because they began operations only a few years ago and lack sufficient quarters of data for forecasting. Secondary data for 39 quarters (2015 Q4 - 2025 Q2) on various bank-specific variables have been collected from the respective 53 commercial banks. Based on historical data of 39 quarters, another 39 quarters (2025 Q3-2035 Q1) have been projected, taking into account the historical trend and the possible intervention of RBS. To project the financial indicators, such as operating income, operating expenses, net income, total assets, total deposits, total loans, total equity, tier 1 capital, and tier 2 capital for another 39 quarters, we have considered the average of 39-quarter historical growth rates of individual banks.

Based on interview data and RBS-related guidance notes, reports, and publications, it can be assumed that RBS will help to recover several financial indicators, including a bank's credit, market, and operational risks, thereby improving the overall classification status of loans. Based on these assumptions, we have plotted three scenarios in our projections: conservative, base, and optimistic. Guided by the opinions and logical arguments of industry experts, policymakers, regulators, and stakeholders as reflected during the interview and focus group discussion, the projection framework for the different scenarios is developed into quantifiable assumptions (Table 1).

Table 1. Projection framework of different scenarios.

Sl.	Variable	Conservative Scenario	Base Scenario	Optimistic Scenario
1.	Operating Income (OpeInc)	$OpeInc_{t+1} = (1+r) \times OpeInc_t$; r = Average quarterly growth rate of OpeInc during 39 quarters (2015Q4-2025Q2)	$OpeInc_{t+1} = (1+r) \times OpeInc_t$; r = Average quarterly growth rate of OpeInc during 39 quarters (2015Q4-2025Q2)	$OpeInc_{t+1} = (1+r) \times OpeInc_t$; r = Average quarterly growth rate of OpeInc during 39 quarters (2015Q4-2025Q2)
2.	Operating Expense (OpeExp)	$OpeExp_{t+1} = (1+r) \times OpeExp_t$; r = Average quarterly growth rate of OpeExp during 39 quarters (2015Q4-2025Q2)	$OpeExp_{t+1} = (1+r) \times OpeExp_t$; r = Average quarterly growth rate of OpeExp during 39 quarters (2015Q4-2025Q2)	$OpeExp_{t+1} = (1+r) \times OpeExp_t$; r = Average quarterly growth rate of OpeExp during 39 quarters (2015Q4-2025Q2)
3.	Net Income (NI)	$NI_{t+1} = (1+r) \times NI_t - 2\%$; where r = Average quarterly growth rate of NI during 39 quarters (2015Q4-2025Q2)	$NI_{t+1} = (1+r) \times NI_t$; where r = Average quarterly growth rate of NI during 39 quarters (2015Q4-2025Q2)	$NI_{t+1} = (1+r) \times NI_t + 2\%$; where r = Average quarterly growth rate of NI during 39 quarters (2015Q4-2025Q2)
4.	Total asset (TA)	$TA_{t+1} = (1+r) \times TA_t$; r = Average quarterly growth rate of TA during 39 quarters (2015Q4-2025Q2)	$TA_{t+1} = (1+r) \times TA_t$; r = Average quarterly growth rate of TA during 39 quarters (2015Q4-2025Q2)	$TA_{t+1} = (1+r) \times TA_t$; r = Average quarterly growth rate of TA during 39 quarters (2015Q4-2025Q2)
5.	Total Deposit (TD)	$TD_{t+1} = (1+r) \times TD_t$; r = Average quarterly growth rate of TD during 39 quarters (2015Q4-2025Q2)	$TD_{t+1} = (1+r) \times TD_t$; r = Average quarterly growth rate of TD during 39 quarters (2015Q4-2025Q2)	$TD_{t+1} = (1+r) \times TD_t$; r = Average quarterly growth rate of TD during 39 quarters (2015Q4-2025Q2)
6.	Total loan (TL)	$TL_{t+1} = (1+r) \times TL_t$; r = Average quarterly growth rate of TL during 39 quarters (2015Q4-2025Q2)	$TL_{t+1} = (1+r) \times TL_t$; r = Average quarterly growth rate of TL during 39 quarters (2015Q4-2025Q2)	$TL_{t+1} = (1+r) \times TL_t$; r = Average quarterly growth rate of TL during 39 quarters (2015Q4-2025Q2)
7.	Total Equity (TE)	$TE_{t+1} = (1+r) \times TE_t$; r = Average quarterly growth rate of TE during 39 quarters (2015Q4-2025Q2)	$TE_{t+1} = (1+r) \times TE_t$; r = Average quarterly growth rate of TE during 39 quarters (2015Q4-2025Q2)	$TE_{t+1} = (1+r) \times TE_t$; r = Average quarterly growth rate of TE during 39 quarters (2015Q4-2025Q2)
8.	Tier 1 capital (Tier1C)	$Tier1C_{t+1} = (1+r) \times Tier1C_t$; r = Average quarterly growth rate of Tier1Cap during 39 quarters (2015Q4-2025Q2)	$Tier1C_{t+1} = (1+r) \times Tier1C_t$; r = Average quarterly growth rate of Tier1Cap during 39 quarters (2015Q4-2025Q2)	$Tier1C_{t+1} = (1+r) \times Tier1C_t$; r = Average quarterly growth rate of Tier1Cap during 39 quarters (2015Q4-2025Q2)
9.	Tier 2 capital (Tier2C)	$Tier2C_{t+1} = (1+r) \times Tier2C_t$; r = Average quarterly growth rate of Tier2Cap during 39 quarters (2015Q4-2025Q2)	$Tier2C_{t+1} = (1+r) \times Tier2C_t$; r = Average quarterly growth rate of Tier2Cap during 39 quarters (2015Q4-2025Q2)	$Tier2C_{t+1} = (1+r) \times Tier2C_t$; r = Average quarterly growth rate of Tier2Cap during 39 quarters (2015Q4-2025Q2)
10.	Credit Risk (CR)	$CR_{t+1} = (1+r) \times CR_t - \frac{r}{20}$; where r = Average of the ratio of credit risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)	$CR_{t+1} = (1+r) \times CR_t - \frac{r}{10}$; where r = Average of the ratio of credit risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)	$CR_{t+1} = (1+r) \times CR_t - \frac{3r}{20}$; where r = Average of the ratio of credit risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)
11.	Market Risk (MR)	$MR_{t+1} = (1+r) \times MR_t - \frac{r}{20}$; where r = Average of the ratio of market risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)	$MR_{t+1} = (1+r) \times MR_t - \frac{r}{10}$; where r = Average of the ratio of market risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)	$MR_{t+1} = (1+r) \times MR_t - \frac{3r}{20}$; where r = Average of the ratio of market risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)
12.	Operational Risk (OR)	$OR_{t+1} = (1+r) \times OR_t - \frac{r}{20}$; where r = Average of the ratio of operational risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)	$OR_{t+1} = (1+r) \times OR_t - \frac{r}{10}$; where r = Average of the ratio of operational risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)	$OR_{t+1} = (1+r) \times OR_t - \frac{3r}{20}$; where r = Average of the ratio of operational risk as a percentage of total loan during 39 quarters (2015Q4-2025Q2)
13.	Classified loan (CL)	$CL_{t+1} = 0.99 \times CL_t$; where $CL_t \geq 9\%$, *otherwise* $CL_{t+1} = CL_t$	$CL_{t+1} = 0.98 \times CL_t$; where $CL_t \geq 9\%$, *otherwise* $CL_{t+1} = CL_t$	$CL_{t+1} = 0.97 \times CL_t$; where $CL_t \geq 9\%$, *otherwise* $CL_{t+1} = CL_t$

We conducted quantitative analysis across all three scenarios.

Bank Stability

This study uses the Z-score [23] to measure bank stability.

$Z\text{-}Score_{i,t}=\frac{ROA_{i,t}+EQT_{i,t}}{\delta(ROA)_{i,t8}}$, where, $ROA_{i,t}$=the return on assets of the bank i in year t; $EQT_{i,t}$= the equity-to-assets ratio of the bank i in year t; and $\delta(ROA)_{i,t8}$= the standard deviation of return on assets of a bank for an 8-quarter rolling window around the period t.

In our main study, we considered the logarithmic transformation of the Z-score. However, in the supplementary analysis, we considered both the raw Z-score with a rolling 8-quarter standard deviation of ROA and the raw Z-score with the standard deviation of ROA across all banks in the country in period t.

Bank Profitability

Both Return on Assets (ROA) and return on equity (ROE) are primarily used to measure bank profitability.

$ROA_{i,t}=\frac{Net\ Income_{i,t}}{Total\ Assets_{i,t}}$ and $ROE_{i,t}=\frac{Net\ Income_{i,t}}{Total\ Equity_{i,t}}$

In the supplementary analysis, we also considered the cost-to-income and operating expense-to-total assets ratios as endogenous variables to assess the cost-side measurement as a robustness check.

All the study variables are defined in Table 2.

Table 2. Description of the variables.

Variable	Definition	Expected Sign
Dependent Variable		
Bank Stability	Logarithmic transformation of Z-score	
ROA	Net income to total assets	
ROE	Net income to total equity	
Cost-to-Income	The ratio of operating expenses to operating income	
Operating expense-to-total assets	The ratio of operating expenses to total assets	
Primary Independent Variable		
RBS	Dummy variable (‘0’ before RBS implementation and ‘1’ after RBS implementation)	+
Controls		
CAR	Capital Adequacy Ratio [(Tier 1 capital + Tier 2 capital)/Risk-weighted Assets]	+
DepAsset	The ratio of total deposits to total assets	+/−
EquityAsset	The ratio of total equity to total assets	+/−
Advdep	The ratio of total advances to total deposits	+/−
RWA	Risk-weighted Assets (Credit, market, and operational risks)	+/−
NPL	The ratio of non-performing loans to total loans	−

The descriptive statistics and matrix of pairwise correlations are shown in Table 3 and Table 4, respectively.

Table 3. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
L Zscore	4134	2.139	.071	2.004	2.250
ROA	4134	.001	.014	-.543	.186
ROE	4134	-.006	.472	-7.845	21.456
CostIncome	4134	1.688	10.424	-373.885	91.863
OpeExpOpeInc	4134	.021	.214	.000	7.382
CAR	4134	.176	.589	-2.83	5.749
DepAsset	4134	.709	.144	.129	1.239
EquityAsset	4134	.064	.215	-1.493	.503
AdvDep	4134	.934	.346	.184	3.496
L RWA	4134	4.273	.593	2.374	6.012
NPL	4134	.135	.179	.000	.998
RBS	4134	.500	.500	.000	1.000

Note: L Z-score: Logarithmic transformation of Z-score expressing bank stability; ROA: Return on Assets; ROE: Return on Equity; CostIncome: Cost to Income ratio; OpeExpOpeInc: Operating expense to operating Income ratio; CAR: Capital Adequacy Ratio; DepAsset: Deposit to Asset ratio; EquityAsset: Equity to Asset ratio; AdvDep: Advance to Deposit ratio; L RWA: Logarithmic transformation of Risk-weighted Assets; NPL: Non-performing loans; RBS: Risk-based Supervision.

During the study period, a few commercial banks in several quarters were burdened with severe non-performing loans, causing significant erosion of their capital, as reflected in Table 3.

Table 4. Matrix of correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) L_Zscore	1.000											
(2) ROA	0.013	1.000										
(3) ROE	-0.028	0.108	1.000									
(4) CostIncome	0.141	-0.060	-0.040	1.000								
(5) OpeExpOpeInc	0.091	-0.008	-0.002	0.267	1.000							
(6) CAR	0.099	0.398	0.073	-0.018	0.018	1.000						
(7) DepAsset	0.035	-0.230	-0.026	0.077	-0.049	-0.553	1.000					
(8) EquityAsset	-0.044	0.368	0.011	0.023	0.037	0.720	-0.476	1.000				
(9) AdvDep	0.078	-0.118	-0.071	0.002	-0.021	-0.153	-0.416	-0.082	1.000			
(10) L_RWA	0.293	0.020	-0.045	-0.042	-0.070	-0.133	0.198	0.062	0.315	1.000		
(11) NPL	-0.040	-0.376	-0.102	0.034	-0.006	-0.361	0.031	-0.437	0.091	-0.228	1.000	
(12) RBS	0.161	-0.006	-0.064	0.149	0.068	0.090	0.028	-0.032	0.058	0.234	-0.020	1.000

Note: L Z-score: Logarithmic transformation of Z-score expressing bank stability; ROA: Return on Assets; ROE: Return on Equity; CostIncome: Cost to Income ratio; OpeExpOpeInc: Operating expense to operating Income ratio; CAR: Capital Adequacy Ratio; DepAsset: Deposit to Asset ratio; EquityAsset: Equity to Asset ratio; AdvDep: Advance to Deposit ratio; L RWA: Logarithmic transformation of Risk-weighted Assets; NPL: Non-performing loans; RBS: Risk-based Supervision.

5.2 Empirical Framework

The econometric model draws upon established literature concerning the determinants of bank stability [24-26] and profitability [27-30]. We enhance the bank-stability model by integrating the RBS variable.

Model 1.0: Base Model

$$\text{Bank stability}_{i,t}=\alpha+\beta_1\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Model 1.1: Including Primary Independent Variable (RBS)

$$\text{Bank Stability}_{i,t}=\alpha+\beta_1\text{RBS}_{i,t}+\beta_2\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Similarly, we extend the conventional bank profitability model by incorporating the RBS variable.

Model 2.1.0: Base Model

$$\text{Bank profitability (ROA)}_{i,t}=\alpha+\beta_1\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Model 2.1.1: Including Primary Independent Variable (RBS)

$$\text{Bank profitability (ROA)}_{i,t}=\alpha+\beta_1\text{RBS}_{i,t}+\beta_2\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Model 2.2.0: Base Model

$$\text{Bank profitability (ROE)}_{i,t}=\alpha+\beta_1\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Model 2.2.1: Including Primary Independent Variable (RBS)

$$\text{Bank profitability (ROE)}_{i,t}=\alpha+\beta_1\text{RBS}_{i,t}+\beta_2\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

As a supplementary analysis to check the association between RBS and bank expenses, we have incorporated the following models as well:

Model 2.3.0: Base Model

$$\text{Bank expenses (Cost-Income)}_{i,t}=\alpha+\beta_1\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Model 2.3.1: Including Primary Independent Variable (RBS)

$$\text{Bank expenses (Cost-Income)}_{i,t}=\alpha+\beta_1\text{RBS}_{i,t}+\beta_2\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Model 2.4.0: Base Model

$$\text{Bank expenses (Operating Expenses-Total Assets)}_{i,t}=\alpha+\beta_1\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Model 2.4.1: Including Primary Independent Variable (RBS)

$$\text{Bank expenses (Operating Expense-Total Assets)}_{i,t}=\alpha+\beta_1\text{RBS}_{i,t}+\beta_2\text{Control variables}_{i,t}+\varepsilon_{i,t}$$

Table 5 presents the detailed identification of the models.

Table 5. Model identification.

Model No.	Dependent Variable	Independent Variables
1.0	Bank Stability	Only controls: (1) CAR, 2) DepAsset, 3) EquityAsset, 4) AdvDep.
1.1	Bank Stability	Include the primary independent variable RBS with Model 1.0
2.1.0	ROA	Only controls: 1) DepAsset, 2) EquityAsset, 3) AdvDep, 4) RWA, 5) NPL
2.1.1	ROA	Include the primary independent variable RBS with Model 2.1.0
2.2.0	ROE	Only controls: 1) DepAsset, 2) EquityAsset, 3) AdvDep, 4) RWA, 5) NPL
2.2.1	ROE	Include the primary independent variable RBS with Model 2.2.0
2.3.0	Cost to Income	Only controls: 1) DepAsset, 2) AdvDep, 3) RWA, 4) NPL
2.3.1	Cost to Income	Include the primary independent variable RBS with Model 2.3.0
2.4.0	Operating Expense to Total Assets	Only controls: 1) DepAsset, 2) AdvDep, 3) RWA, 4) NPL
2.4.1	Operating Expense to Total Assets	Include the primary independent variable RBS with Model 2.4.0

Note: CAR: Capital Adequacy Ratio; DepAsset: Deposit to Asset ratio; EquityAsset: Equity to Asset ratio; AdvDep: Advance to Deposit ratio; RBS: Risk-based Supervision; RWA: Risk-weighted Assets; NPL: Non-performing loans; ROA: Return on Assets; ROE: Return on Equity.

5.3 Research Method

The collected time-series data were processed and analyzed using Stata 19.5. In Stata, the data set has been declared as a time series. Skewness and kurtosis tests were run to assess normality for each variable included in the models, and all were found to be normally distributed.

All variables are checked for trends. It is also checked whether the trend is linear, quadratic, or cubic. Based on the found trend pattern, all variables are made detrended [31]. Later, all detrended variables are checked for seasonality. If

any seasonality is detected, these variables are deseasonalized [32]. Besides, the variables used in a regression model must be stationary to avoid spurious regression. A unit root test was conducted to determine whether the data set was stationary in levels or in first differences. To check whether the data set is stationary at which level, the Augmented Dickey-Fuller test [33] was run, and the results were cross-checked with the Phillips-Perron test [34].

This study employs panel data analysis, a statistical procedure suitable for examining data from multiple relevant entities over time [35-36]. Panel data analysis captures both within-unit and between-unit variations. This method yields insights into individual behaviors and the dynamics of change. Specifically, it enables analysis of differences among individual banks and temporal changes within the same bank.

Fixed- and random-effects regression models are applied to the panel data, and the most appropriate model is selected for each case. The Durbin-Wu-Hausman (DWH) test is used to assess whether the coefficients differ significantly [37]. A significant DWH test result indicates that the fixed effects model is appropriate [38]. If the DWH test is not significant, the Breusch-Pagan test is conducted to determine the presence of random effects [39]. A significant result from this test confirms that the random effects model is most appropriate.

In this study, we employ standardized regression coefficients. These coefficients represent values in statistically comparable units, which facilitates direct comparison [40].

Multiple diagnostic tests were conducted to assess the validity of each model. The variance inflation factor (VIF) was used to examine multicollinearity. A two-stage least squares (2SLS) test was conducted to assess endogeneity. The Durbin-Watson test [41] and the Breusch-Godfrey test [42,43] were applied to detect autocorrelation. White's test [44] was employed to identify heteroscedasticity in the models.

6. Results of Panel Data Analysis Based on Historical Data and Scenario-Based Estimates

6.1 Positive Association Between RBS and Bank Stability

Regarding Hypothesis 1, tested in Model 1.1, the results of panel data analysis, based on the historical data before implementing RBS and scenario-based estimates after implementing RBS, presented in Table 6, support a highly statistically significant positive association between RBS and bank stability ($\beta_1 = 0.071$, $p < 0.01$).

Table 6. Results of panel data analysis in base scenario (dependent variable: log of Z-score).

Model	**1.0**		**1.1**	
Variables	**Fixed Effect**	**Random Effect**	**Fixed Effect**	**Random Effect**
CAR	0.227***	0.217***	0.227***	0.218***
	(0.019)	(0.018)	(0.018)	(0.018)
DepAsset	0.309***	0.305***	0.312***	0.308***
	(0.027)	(0.026)	(0.027)	(0.026)
EquityAsset	0.869***	0.835***	0.863***	0.831***
	(0.031)	(0.029)	(0.031)	(0.028)
AdvDep	0.168***	0.163***	0.170***	0.165***
	(0.022)	(0.021)	(0.021)	(0.021)
RBS			0.071***	0.071***
			(0.009)	(0.009)
Constant	0.000	0.000	0.000	0.000
	(0.009)	(0.064)	(0.009)	(0.064)
Number of Banks	53	53	53	53
Observations	4,134	4,134	4,134	4,134
R-squared within	0.2053	0.2053	0.2185	0.2184
R-squared between	0.6494	0.6487	0.6488	0.6481
Overall R-squared	0.4771	0.4768	0.4816	0.4814
F-statistics/Wald $\chi 2$	263.34***	1140.55***	227.87***	1226.89***
F-test	56.29 ***		57.19***	
Hausman's Test	19.56***		18.96***	

Note: ***p<0.01, **p<0.05, p<0.1; The most robust models are highlighted in bold. CAR: Capital Adequacy Ratio; DepAsset: Deposit to Asset ratio; EquityAsset: Equity to Asset ratio; AdvDep: Advance to Deposit ratio; RBS: Risk-based Supervision.

6.2 Negative Association Between RBS and Bank Profitability

Regarding Hypothesis 2, tested in Model 2.1.1, the results of panel data analysis, based on the historical data before implementing RBS and scenario-based estimates after implementing RBS, presented in Table 7, support a highly statistically significant negative association between RBS and bank profitability, as measured by ROA ($\beta_1 = -0.404$, $p < 0.01$).

Table 7. Results of panel data analysis in base scenario (dependent variable: ROA).

Model	**2.1.0**		**2.1.1**	
Variables	**Fixed Effect**	**Random Effect**	**Fixed Effect**	**Random Effect**
DepAsset	-0.343***	-0.436***	-0.278***	-0.275***
	(0.03)	(0.03)	(0.03)	(0.03)
EquityAsset	0.107***	-0.039	0.254***	0.128***
	(0.04)	(0.03)	(0.04)	(0.03)
AdvDep	-0.452***	-0.481***	-0.293***	-0.267***
	(0.03)	(0.02)	(0.02)	(0.02)
RWA	1.331***	1.030***	0.655***	0.427***
	(0.02)	(0.02)	(0.03)	(0.03)
NPL	-0.350***	-0.259***	-0.285***	-0.231***
	(0.02)	(0.02)	(0.02)	(0.02)
RBS			-0.404***	-0.480***
			(0.02)	(0.01)
Constant	0.000	0.000	0.000	0.000
	(0.01)	(0.04)	(0.01)	(0.04)
Number of Banks	53	53	53	53
Observations	4,134	4,134	4,134	4,134
R-squared within	0.4507	0.4410	0.5349	0.5267
R-squared between	0.1555	0.1947	0.3435	0.4266
Overall R-squared	0.1713	0.1943	0.3702	0.4548
F-statistics/Wald $\chi 2$	668.89***	2308.42***	781.06***	4409.16***
F-test	49.16***		18.28***	
Hausman's Test	1570.70***		187.10***	

Note: ***p<0.01, **p<0.05, *p<0.1; The most robust models are highlighted in bold. DepAsset: Deposit to Asset ratio; EquityAsset: Equity to Asset ratio; AdvDep: Advance to Deposit ratio; RWA: Risk-weighted Assets, NPL: Non-performing loans; RBS: Risk-based Supervision.

Moreover, Hypothesis 2, tested in Model 2.2.1, the results of panel data analysis, based on the historical data before implementing RBS and scenario-based estimates after implementing RBS, are presented in Table 8, also support a highly statistically significant negative association between RBS and bank profitability, as measured by ROE ($\beta_1 = -0.240$, $p < 0.01$).

Table 8. Results of panel data analysis in base scenario (dependent variable: ROE).

Model	2.2.0		2.2.1	
Variables	**Fixed Effect**	**Random Effect**	**Fixed Effect**	**Random Effect**
NPL	-0.233***	-0.173***	-0.194***	-0.161***
	(0.03)	(0.02)	(0.03)	(0.02)
DepAsset	-0.191***	-0.299***	-0.153***	-0.190***
	(0.04)	(0.03)	(0.04)	(0.03)
EquityAsset	-0.432***	-0.318***	-0.345***	-0.224***
	(0.05)	(0.04)	(0.05)	(0.04)
AdvDep	-0.299***	-0.328***	-0.205***	-0.193***
	(0.03)	(0.03)	(0.03)	(0.03)
RWA	0.782***	0.546***	0.381***	0.187***
	(0.03)	(0.03)	(0.05)	(0.03)
RBS			-0.240***	-0.306***
			(0.02)	(0.02)
Constant	0.00	0.00	0.00	0.00
	(0.01)	(0.04)	(0.01)	(0.04)
Number of Banks	53	53	53	53
Observations	4,134	4,134	4,134	4,134
R-squared within	0.1468	0.1396	0.1740	0.1693
R-squared between	0.0008	0.0039	0.0005	0.0410
Overall R-squared	0.0282	0.0418	0.0899	0.1429
F-statistics/Wald $\chi 2$	140.25***	478.17***	143.11***	815.47***
F-test	15.83***		8.21***	
Hausman's Test	237.78***		44.42***	

Note: ***p<0.01, **p<0.05, *p<0.1; The most robust models are highlighted in bold. NPL: Non-performing loans; DepAsset: Deposit to Asset ratio; EquityAsset: Equity to Asset ratio; AdvDep: Advance to Deposit ratio; RWA: Risk-weighted Assets; RBS: Risk-based Supervision.

6.3 Robustness Check

As a robustness check, we considered a fictitious RBS implementation timing (Q1 of 2020), and for our projected scenario (base), we found no significant association between RBS and bank stability (β_1= 0.012, n.s); between RBS and bank profitability, measured by ROA (β_1= −0.311, n.s); and between RBS and bank profitability, measured by ROE (β_1= −0.071, n.s). This corroborates the validity of the significant association of RBS with both bank stability and profitability.

Moreover, we considered three scenarios in our projection. The results of the panel data analysis for the separate scenarios are exhibited in Table 9.

Table 9. Results of panel data analysis of scenario-based estimates (supplementary analysis).

Scenario	Model	Dependent Variable	Primary Independent Variable (RBS)
1	1.1	Bank Stability	β_1= 0.071, p < 0.01
2	1.1	Bank Stability	β_1= 0.076, p < 0.01
3	1.1	Bank Stability	β_1= 0.071, p < 0.01
1	2.1.1	ROA	β_1= −0.404, p < 0.01
2	2.1.1	ROA	β_1= −0.121, p < 0.01
3	2.1.1	ROA	β_1= −0.628, p < 0.01
1	2.2.1	ROE	β_1= −0.240, p < 0.01
2	2.2.1	ROE	β_1= −0.097, p < 0.01
3	2.2.1	ROE	β_1= −0.369, p < 0.01

Note: In the table of supplementary analysis, only the coefficients of the primary independent variable (RBS) are shown. All controls are also significant, as in the main results of the base scenario shown in previous tables.

As we found through panel data analysis, based on the historical data before implementing RBS and scenario-based estimates after implementing RBS, that RBS has a negative association with bank profitability, we investigated further by considering the cost-to-income and operating expense-to-total assets ratios as dependent variables in Models 2.3.1 and 2.4.1, respectively, to assess the cost-side measurement as a robustness check. Based on three scenarios, we are primarily satisfied that there is a negative association between RBS and bank expenses, including both cost-to-income (β_1= −0.086, p < 0.01; β_1= −0.076, p < 0.01; and β_1= −0.011, n.s) and operating expense-to-total assets (β_1= −0.107, p < 0.01; β_1= −0.025, p < 0.05; and β_1= −0.019, p < 0.1). This further corroborates the validity of the scenario analysis results.

Again, as a robustness check, we considered bank stability measurements in different ways, in addition to our main study, which uses the logarithmic transformation of the Z-score. The other measurements of the Z-score that we have considered are i) raw Z-score with rolling 8 quarters' standard deviation of ROA, and ii) raw Z-score with considering the standard deviation of ROA of all banks in the country in period t. In the case of raw Z-score with rolling 8 quarters' standard deviation of ROA, we found a positive and significant association between RBS and bank stability in all three scenarios (β_1= 0.137, p < 0.01; β_1= 0.142, p < 0.01; and β_1= 0.011, p < 0.1, respectively). In addition, in the case of raw Z-score, considering the standard deviation of ROA of all banks in the country, we found a positive and significant association of RBS with bank stability in all three scenarios (β_1= 0.014, p < 0.05; β_1= 0.014, p < 0.05; and β_1= 0.015, p < 0.05, respectively). So, the association between RBS and bank stability is validated in various ways using different scenario-based estimates, demonstrating the robustness of our models.

7. Discussion

The operationalization of RBS in contemporary banking supervisory procedures has been an instrumental paradigm shift in the oversight of banking operations worldwide. This supervisory intervention has been termed the transformation of traditional supervisory mechanisms into cutting-edge supervisory dynamics, equipped with advanced, practical, and actionable supervisory tools that focus on each bank's idiosyncratic risk profile for risk identification. Given the fact that the traditional supervisory process often overlooks the intricacies of the banks' diverse set of risk exposures, RBS has become an ultimate option for banking supervision, especially after the turbulent years of the global financial crisis, as well as the emergence of newer threats to the banking industry due to changes in banking operations.

The results of scenario analysis suggest that RBS has a significant positive association with bank stability in all scenario-based estimates. As RBS can proactively address specific risks for a particular bank, it helps prevent vulnerabilities and enhance stability. However, the results of scenario analysis also indicate that RBS has a negative association with bank profitability. Bangladesh has just implemented RBS in the banking sector. So, in the initial stage, it may adversely affect profitability due to the costs of developing IT infrastructure, implementing enhanced management control systems, and hiring skilled, well-trained employees. However, we assume that the negative association between RBS and profitability stems from initial cost adjustments in certain areas related to banking supervision. When all banks can cope with proactive supervisory measures, profitability may improve.

The success of RBS depends on how higher-risk banks are supervised and on ensuring flexible supervision for lower-risk banks. RBS also requires effective risk control mechanisms that enhance resilience and leverage technology to ensure smooth surveillance of the digital interface, among other measures. However, obstacles hinder the effectiveness of RBS. Human judgment in risk management often leads to inconsistency [12]. Inadequate resource mobilization poses a challenge to the implementation of the RBS. Sometimes, RBS's more stringent supervisory practices impede efficiency. A high-quality institutional framework and coordination among stakeholders are other considerations for RBS.

8. Conclusion, Limitation, and Future Directions

Our analysis of all three projected scenarios, based on historical data before implementing RBS and scenario-based estimates after implementing RBS, shows a positive association between RBS and bank stability, whereas there is a negative association between RBS and bank profitability. Effective supervision ensures proactive measures to maintain asset quality, prevent capital erosion, reduce non-performing loans, and ultimately ensure bank stability.

As Bangladesh has recently introduced RBS, some banks may face challenges adapting to the new systems, which may initially reduce their profitability. When all commercial banks are fully prepared for the new system, we can expect both stability and profitability to improve. In the current scenario, the risk profile, non-performing loan ratio, capital adequacy, etc., are not uniform across all banks. Moreover, not all commercial banks in Bangladesh are equally technologically equipped. Some banks are more digitally advanced than others, with innovative software and a tech-savvy workforce. Moreover, supervisors in Bangladesh have only recently begun RBS. They need to be well-capable in handling the transition from rule-based to RBS. In this situation, continuous training for supervisors, stress testing, risk assessment techniques, data analytics, and close scrutiny of high-risk banks are indispensable for the success of RBS.

The effectiveness of RBS in a developing country like Bangladesh is a major concern. Hence, Bangladesh should regularly compare its RBS framework with global and regional standards to identify gaps and adopt best practices. In

addition, the effectiveness of RBS in the region and similar economies needs to be explored to better understand the situation and, accordingly, take timely measures to ensure banking stability. Furthermore, integrating advanced data analytics, artificial intelligence, and machine learning will play a significant role in reshaping RBS's future outlook.

A balanced approach that unites technological innovation, strong governance, data-driven oversight, transparent communication, and sound supervisory proficiency is essential to strengthening banking stability and sustaining public trust in the financial sector.

Although our study has several important findings based on scenario analysis, it has a few limitations. To examine the association of RBS with bank stability and profitability, we projected the bank-specific variables. The projections are primarily based on historical trends and assumptions, informed by insights from expert opinions, focus group discussions, and stakeholder interviews considering the RBS intervention. These assumptions may differ from reality in the future. In that case, the findings may vary. Actual data, rather than any projections, can provide a more accurate impact assessment. Moreover, in the near future, digital transformation (DT) in the banking sector may introduce a new dimension that could affect overall financial dynamics. We have not considered the impact of DT in our projection.

This quantitative study on the association between RBS and bank stability and profitability at the emerging-country level opens the door to further research. Future research should examine the impact of RBS across different categories of banks, including state-owned, private, Islamic, and foreign commercial banks, to inform future planning. Regional research can identify country-specific factors that may produce significant findings. Additionally, comparative analysis of similar economies with respect to RBS and bank stability represents a promising research direction.

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Ethics Statement

The study was conducted in accordance with the Declaration of Helsinki. It was approved by the Financial Stability Department of Bangladesh Bank (the Central Bank of Bangladesh).

Informed Consent

Informed consent was obtained from all human participants involved in the study.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

Dr. Bhaskar Podder: Conceptualization, Methodology, Writing – Original Draft; Musammet Ismat Ara Begum: Drafting literature review, primary data collection, and preparation of the related write-up; Soumen Chakravarty: Drafting literature review and primary data collection; Razia Sultana: Secondary data compilation and processing.

Conflict of Interest

The authors declare no conflict of interest.

Generative AI Statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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Appendix 1

Table A1. Interview guidelines.

Locating the interviewees in the conversation
a. Conversation around
- business type, role and responsibilities, nature, and idea regarding RBS
b. Elaborate on research objectives and familiarize with the informed consent form
Discussions on Rule-based and Risk-based Supervision
-Insight regarding Rule-based and Risk-based Supervision in the context of your bank/organization.
-What do you expect regarding the financial indicators of your bank after RBS implementation?
-Which entity-specific financial indicators may improve after RBS implementation? Would you please share your opinion on the magnitude of the improvement and the reasons for your assumption?
-Which entity-specific financial indicators may degrade after RBS implementation? Would you please share your opinion on the magnitude of the degradation and the reasons for your assumption?
Involvement in the RBS process
- Your role in the organization related to the RBS process.
Comments on RBS
- Describe the conveniences or difficulties with RBS from your organizational perspective.
- Preparedness of your bank for RBS.
- Do you think all banks will be capable of responding to RBS in a similar way?
Other issues related to RBS
- Describe any other issues that you think should be considered in this process.

Appendix 2

Table A2. Construction of themes from interview data.

First order of codes	Second order of codes	Third order of codes	Overall theoretical dimension
Dynamic supervision	Effective supervision	Enhance asset quality	Bank Stability
Not uniform but risk-specific supervisory measures			
Regular supervisory attention			
Proactive monitoring of clients	Effective monitoring		
Daily dashboard reporting			
Data accuracy			
Strong governance			
Risk identification	Reduction of risks	Reduce capital erosion	
Risk mitigation			
Risk governance			
Reduction of credit risk	Reduction of non-performing loan		
Reduction of market risk			
Reduction of operational risk			
Software development	IT infrastructure development	IT expenses	Bank Profitability
Advanced data management system			
Software upgradation			
Advanced data analytics			
Deploy an additional IT expert workforce	Increase in salary expenses	Increase in operating costs	
Hiring a skilled workforce			
Hiring experts			
Employee awareness	Training cost		
Ongoing employee training			
Employee preparedness	Management cost		
Advances MIS			
Costs of new supervisory systems			