Macrothink Institute™

International Finance and Banking
ISSN 2374-2089
2023, Vol. 10, No. 1

Identifying Efficiency of Banks' Performance Using Financial Indicators in Bangladesh During the COVID-19 Pandemic: Analysis of Slack-Based DEA Approach

Nobinkhor Kundu (Correspondence author)

Associate Professor, Department of Economics, Comilla University

Cumilla-3506, Bangladesh

E-mail: nobinkundu@cou.ac.bd

Mst. Noiyan Tara

Assistant Professor, Department of Economics

Comilla University, Cumilla-3506, Bangladesh

E-mail: noiyan19@cou.ac.bd

Gazi Mohammed Mahbub

Assistant Professor, Department of Economics

BSMRST University, Gopalganj-8100, Bangladesh

E-mail: gazimohammedmahbub@gmail.com

Received: March 9, 2023 Accepted: October 10, 2023 Published: December 8, 2023

doi:10.5296/ifb.v10i1.20480 URL: http://dx.doi.org/10.5296/ifb.v10i1.20480

Abstract

The purpose of this study is to examine slack-based data envelopment analysis (DEA) to determine the efficiency of commercial bank performance in Bangladesh at post-Basel III in the COVID-19 pandemic. The secondary data was gathered from several annual reports of forty-three commercial banks in Bangladesh for the year 2020. This study found that thirteen DMUs indicating that "perfectly efficient" financial ratios. Moreover, six DMUs obtained

efficiency scores of 90 percent to 99 percent, and nine DMUs obtained efficiency scores of 80 percent to 89 percent, which indicates that they have a “highly efficient” financial ratio. The bank efficiency score ranges from 60 percent to 79 percent, which indicates that fifteen DMUs have “moderately efficient” financial ratios. Thus, DMU_2 is the most efficient, which indicates “perfectly efficient” financial ratios, and DMU_6 is the least efficient, which indicates “moderately efficient” financial ratios amongst the selected forty-three commercial banks in Bangladesh.

Keywords: Bank Performance, Efficiency, COVID-19, Financial Ratios, DEA, Bangladesh

1. Introduction

Banking transactions have been affected in the globalisation age as a result of the coronavirus disease 2019 (COVID-19) pandemic (WHO, 2021). Following COVID-19, the banking industry experienced drastic changes but remained a financial intermediary for bank operations. Commercial banks are still suffering due to the failure of the market, particularly in developing countries (Alexakis et al., 2019). Indeed, we investigate various types of commercial banks' actual financial ratio positions and financial intermediaries' net positions indicate stability and risk-averse behavior during the COVID-19. Bangladesh is a developing country with an impoverished banking system following its liberation, notably in terms of financial ratios (Kamarudin et al., 2016). Also, Islamic banking outperforms conventional commercial banks in Bangladesh, and they also exhibit variances in inefficiency due to a variety of circumstances (Asmild et al., 2019). In this regard, it should be noted that the commercial banks of Bangladesh appear to be challenging the bank's financial ratios.

In recent years, commercial banks have attempted to emulate the banking structures of more developed countries, but their efforts have frequently been hindered by COVID-19. The administration allowed the lockdown to cease implicitly and then formally, despite an increasing COVID-19 burden (Ali et al., 2021). Bangladesh's commercial banks' cost efficiency is critical for financial reform in the country's financial industry (Robin et al., 2018). Consider that financial indicators are the primary factors for efficiency measurement. The reasons for the lower performance are increased non-performing loans and increased costs, which are indirect indicators of poor corporate governance in Bangladesh (Mahbub et al., 2019). Whilst bank costs have decreased as a result of financial deregulation, the presence of lockdowns and social distances has a detrimental effect on efficiency during the COVID-19 pandemic (Hossain et al., 2021), which indicates that all units are not operating at the desired level of efficiency in the Bangladeshi banking sector (Robin et al., 2019).

International regulatory efforts have been concentrated on promoting the implementation of international capital norms and the Basel Core Principles (BCP) (Note 1) for effective bank supervision in order to improve bank operational efficiency (Ayadi et al., 2016). The Basel-III reforms are aimed at strengthening bank regulation, supervision, and risk management (Vazquez & Federico, 2015). We considered Basel's implementation in the banking sector and the impact of financial ratio risk on commercial banks in Bangladesh. Moreover, we want to emphasize that a bank's failure depends on its most critical financial ratio and non-performing loans. The COVID-19 demonstrated the critical role of regulation and supervision in maintaining a healthy banking sector capable of efficiently channeling financial resources into investment. Most crucially, the influence of Basel III is on the banking sector's performance in Bangladesh during the COVID-19 pandemic.

We mention here that we concentrated on the efficiency scores of the DEA model in order to determine the financial ratio efficiency of each commercial bank during the COVID-19 pandemic. The purpose of the analysis is to assess the efficiency of the financial ratios of the commercial banking system in Bangladesh during the period 2020. In general, this research paper aims to investigate the significant effects of the financial ratios on the performance of

commercial banks in Bangladesh. To accomplish the aforementioned background of the study, the study's precise objectives would be as follows. The objective of the research is to identify the efficient commercial banks based on financial ratios employed in slack-based data envelopment analysis in Bangladesh and also examine the policy suggestions for achieving the financial efficiency of commercial banks in Bangladesh.

Worldwide, economists are considering the aftermath of the terrible GFC, and emphasis has shifted to Islamic banking and finance as a possible alternative model to the demise of major Middle Eastern and Asian banks (Rosman et al., 2014) and Turkish banks (Sahin et al., 2016). The Malmquist productivity index is used to compare the performance and productivity of Islamic and conventional banks in the GCC group of countries (Alexakis et al., 2019), the European banking system (Degl'Innocenti et al., 2017), and Taiwan's commercial banks (Lin, Hsu, & Hsiao, 2007). As an incentive program, the government has initiated financial reform packages aimed at enhancing managerial efficiency (Isik & Hassan, 2002). We investigated the efficiency of Taiwan's commercial banks (Kao & Liu, 2009) and Chinese commercial banks (Wang et al., 2014) as a proxy for decision-making units (DMUs) using an additive two-stage DEA model.

Under the assumption of unit homogeneity, DEA measured selected input-output variables and weights, and analysed pitfalls and protocol (Dyson et al., 2001). The DEA model is examined in its primal and dual forms, as well as in single-stage and two-stage approaches (Green & Doyle, 1997). The DEA model for managerial quality and quantified managerial efficiency in the US banking industry (Barr et al., 1993), and various managerial capacities for efficiency development in Canadian commercial banks (Kundu et al., 2019; Paradi, Zhu, & Edelstein, 2012). Cost efficiency has a greater impact on profitability when banks take on greater risk and face increased competition (Fang et al., 2019). The cost and profit efficiency of the Vietnamese banking system are quantified using the DEA model, and the average efficiency score of the banking system is calculated using a bank size average of roughly 0.90 and 0.75, respectively (Nguyen et al., 2014).

An empirical investigation compared inefficient banks with efficient banks using simple ratio analysis in terms of performance. DEA is a widely used technique for determining the financial ratios of the relative efficiency of homogeneous decision-making units (DMUs) (Ablanedo-Rosas et al., 2010; Cook et al., 2014; Dyson et al., 2001; Zahedi-Seresht et al., 2021). The DEA approach was used to assess the technical, allocative, and cost efficiency of Turkey's conventional banks (Eyceyurt Batir et al., 2017). Financial ratios are used to estimate the Greek banking sector's efficiency using the DEA model (Halkos & Salamouris, 2004). For example, nonperforming loans (NPLs) are an unfavorable outcome that has a detrimental effect on the technical efficiency of Turkish banks (Partovi & Matousek, 2019).

The combination of a slacks-based measure of DEA, which finds peer-based standards for ratio analysis (Barr et al., 1993), and a modest profitability efficiency model, emerges as the most significant explanation for the variation in financial ratios (Avkiran, 2011). For the first time, the slacks-based DEA model is used to aggregate the efficiency scores (Paradi & Schaffnit, 2004) and operating unit performance: production, profitability, and intermediation (LaPlante

& Paradi, 2015). A two-stage dynamic network DEA approach in Taiwanese banks is created for measuring the performance of operational units concurrently (Yu et al., 2021), and the resultant efficiency scores are calculated using a modified Slacks-based DEA model (Paradi et al., 2011). In the post-GFC period, the profit efficiency of 31 commercial banks operating in Bangladesh was determined using the Slack-based DEA approach. The market concentration is significantly unfavorable for SCBs but good for PCBs (Kamarudin et al., 2016). Numerous scholars have examined PCBs' performance efficiency of financial ratios by using the DEA model (e.g., Avkiran, 2011; Barr et al., 1993; Dyson et al., 2001; LaPlante & Paradi, 2015; & Rosman et al., 2014).

We examined the efficiency levels of state-owned commercial banks (SCBs), private commercial banks (PCBs), including conventional PCBs and Islami Shariah-based PCBs, and foreign commercial banks (FCBs) that employed DEA by financial ratios in Bangladesh for the year 2020. While the majority of these conventional PCBs, Islamic PCBs, and foreign banks were scale-efficient, others were inefficient and operated at decreasing returns to scale (Rosman et al., 2014). According to DEA and stochastic frontier analysis (SFA) with financial ratios, conventional banks were more efficient than their Islamic equivalents in 18 OIC (Organization of Islamic Conference) nations during the GFC (Mobarek & Kalonov, 2014). The link between risk, capital, and efficiency is examined using SFA for state-owned, foreign, Islamic, and conventional PCB banks. For conventional PCBs and FCBs, greater cost efficiency correlates with decreased risk during COVID-19, but the opposite is true for SCBs and Islamic PCBs (Saeed et al., 2020; Safiullah & Shamsuddin, 2020). In general, Islamic banks are less technically efficient than conventional banks.

As mentioned previously, the majority of applications of the widely used frontier technique, data envelopment analysis (DEA), examine the relationship between efficiency estimates and key performance measures. However, no empirical test for financial ratios of SCBs, PCBs, and FCBs in Bangladesh using DEA has been discovered. We studied the impact of financial ratio risk on SCBs, PCBs, and FCBs in Bangladesh. It is generally considered that Basel-III covers financial ratio risk, and efficient financial ratios are a real reflection of the banking sector's long-term financial health and economic growth. The focus of this research article is on the use of financial-banking efficiency ratios as efficiency indicators, rather than the more commonly utilized input-output variables in practically all banking applications.

The remainder of the paper is structured in the following manner. Section 2 describes the growth of financial ratios of commercial banks' performance in Bangladesh during the COVID-19, including descriptive statistics. Section 3 contains data and methodology. DEA used Section 4 findings of the financial ratios to assess bank performance efficiency during COVID-19. The final portion discusses concluding remarks.

2. Financial Indicators: COVID-19 Facts

2.1 Growth of Financial Ratios

The empirical analysis examines the financial ratios that are affected by COVID-19 that influences selected schedule banks' efficiency performance in Bangladesh. This study finds

out the growth of financial ratios using data from several annual reports from a selected forty-three commercial banks, shown in the list of selected commercial banks in appendix A4, in Bangladesh during the periods 2019 and 2020. The scatter plot of the growth of financial ratios, as well as return on assets (ROA), return on equity (ROE), cost and income ratio, net interest margin, capital adequency, leverage, non-performing loans to total loans, and coverage ratio are shown in appendix A1; and the scatter plot of the linear trend of financial ratios is shown in Appendix A2.

The Return on Assets (ROA) measures "the profitability of a company's assets that are generating revenue. Generally, ROA indicates that the capital intensity of the company depends on total assets". This graph indicate that growth of ROA for the 2 SCBs (DMU_1, DMU_4), 12 conventional PCBs (DMU_5, DMU_8, DMU_9, DMU_{10}, DMU_{14}, DMU_{16}, DMU_{17}, DMU_{19}, DMU_{20}, DMU_{21}, DMU_{26}, and DMU_{33}), 12 conventional PCBs (DMU_5, DMU_8, DMU_9, DMU_{10}, DMU_{14}, DMU_{16}, DMU_{17}, DMU_{19}, DMU_{20}, DMU_{21}, DMU_{26}, and DMU_{33}), 3 Islami Shariah-based PCBs (DMU_{36}, DMU_{37}, and DMU_{39}), and FCB (DMU_{42}) is positive , but rest of the all categories DMUs is negative. It is clearly seen from the financial ratios that the ROA of 14 DMUs is more than one percentage during the COVID-19, which indicates that DMUs net income is more than 100 taka for each 100 taka of total assets. On the contrary, ROA of the rest of the DMUs are less than one percent, which indicates that DMUs net income is less than 100 taka for each 100 taka of total assets.

The Return on Equity (ROE) evaluates "a firm's profit before taxes in relation to its total shareholders' equity. Generally, if this return is higher, owners are better off". This graph indicates that ROE growth for the 3 SCBs (DMU_1, DMU_3, and DMU_4), 15 conventional PCBs (DMU_5, DMU_8, DMU_9, DMU_{10}, DMU_{14}, DMU_{16}, DMU_{17}, DMU_{19}, DMU_{23}, DMU_{26}, DMU_{27}, DMU_{29}, DMU_{30}, DMU_{32}, and DMU_{33}), and 4 Islami Shariah-based PCBs (DMU_{34}, DMU_{36}, DMU_{37}, DMU_{39}) are positive but rest of the all categories schedule banks, including all FCBs, are negative. From the figures, it is clearly seen that the ROE of 21 DMUs is more than ten percent, which indicates that those DMUs return more than 1,000 taka on each 100 taka of total equity. On the contrary, the ROE of 18 DMUs is less than ten percent, which indicates that those DMUs' returns are more than 100 taka on each 100 taka of total equity. Moreover, the ROE of four DMUs is less than one percent, which indicates that those DMUs' returns are less than 100 taka on each 100 taka of total equity.

The cost-to-income ratio is defined "as the ratio of an organization's operating expenses to its operating income for a given year. In this context, operating expenses encompass all costs associated with running the firm, including fixed costs (rent, mortgage, insurance, utilities, and property taxes), whereas revenue includes sales revenues, fee income, and interest collected on loans". This figure suggests that the growth of the cost-to-income ratio for the 2 SCBs (DMU_1, DMU_2), 22 conventional PCBs (DMU_6, $DMU_{8\text{-}13}$, DMU_{15}, DMU_{16}, DMU_{18}, DMU_{20}, $DMU_{22\text{-}26}$, and $DMU_{28\text{-}33}$), and all Islami Shariah-based PCBs, except DMU_{37}, and FCB (DMU_{43}) is positive. During the COVID-19, it is clearly seen from the figures that all DMUs' cost-to-income ratios are double digit percentages with a positive sign, only DMU_{33} is three digit percentages with a positive sign, in relation to operating income.

The net interest margin is calculated "as a percentage of net interest margins (net interest income less total expenses) as a percentage of total loans". This figures suggests that growth of net interest margin for the 2 conventional PCBs (DMU_5, DMU_{13}), 2 Islami Shariah-based PCBs (DMU_{37}, DMU_{40}), and FCB (DMU_{42}) are positive, but rest of the all categories DMUs, including SCBs, are negative. According to these figures, during the COVID-19 most of the DMUs' net interest margins are in the single digits with positive , five DMUs are less than one digits with positive , and only DMU_1 and DMU_4 are negative.

The leverage ratio is determined by "the ratio of total equity to total assets. The greater this ratio, the greater the financial leverage and, hence, the greater the risk and potential return". This figures suggests that growth of leverage ratio for all SCBs excluding only DMU_1, 9 conventional PCBs (DMU_5, DMU_{7-9}, DMU_{13}, DMU_{15}, DMU_{17}, DMU_{23}, and DMU_{28}), and 2 Islami Shariah-based PCBs (DMU_{37}, DMU_{41}) are positive, but rest of the all DMUs, including all FCBs, are negative. From the figures, the proportion of total equity as a share of the DMU's total assets is the highest. Specifically, 34 DMUs have positive leveraged ratios in the double digits, while the remaining DMUs have positive leveraged ratios in the single digits during COVID-19.

The Capital Adequency Ratio (CAR) is "a ratio that expresses total equity as a percentage of the risk-weighted assets of a bank; it is also referred to as the capital to risk-weighted assets ratio. This percentage was employed to protect depositors and ensure the stability and efficiency of the world's financial markets". This data suggests that growth of CAR for the all SCBs except DMU_4, 13 conventional PCBs (DMU_5, DMU_8, DMU_{10}, DMU_{11}, DMU_{13}, DMU_{17}, DMU_{18}, DMU_{23}, DMU_{26}, DMU_{27}, and DMU_{31-33}), all Islami Shariah-based PCBs, except DMU_{36}, DMU_{39}, and DMU_{40}, and all FCBs are positive. We have determined from the figures that most of the DMUs' CARs are double digit with a positive, and the remaining six DMUs' CARs are single digit with a positive throughout 2020 at COVID-19.

The non-performing loans ratio compares "the amount of NPLs to total loans over a given time period". This data suggests that the growth of the non-performing loans ratio for all SCBs except DMU_4, all conventional PCBs except DMU_{20}, DMU_{28}, and DMU_{31-33}, and all Islami Shariah-based PCBs except DMU_{37} is negative. The rest of all scheduled banks, including all FCBs, are positive. This chart illustrates the ratio of non-performing loans to total loans at DMUs. From the figures, non-performing loan ratios of most of the DMUs are single digits with a positive , DMU_{1-5} are double digits with a positive , and only DMU_{27}, DMU_{30}, and DMU_{43} are less than one percent.

The coverage ratio is a number that indicates "the provision for loan losses as a percentage of a bank's non-performing loans". This figure suggests that the growth rate of coverage ratio for the 17 conventional PCBs (DMU_7, DMU_{9-12}, DMU_{14}, DMU_{17-19}, DMU_{22-27}, DMU_{29}, and DMU_{30}), and 4 Islami Shariah-based PCBs (DMU_{34}, DMU_{36}, DMU_{39}, and DMU_{41}) is positive. All the SCBs and FCBs, and the rest of the DMUs are negative. The figures clearly show that during COVID-19, the coverage ratios of the majority of the DMUs are in the double digits with a positive. The remaining seven DMUs are single digits with a positive, which are two SCBs and three Islami Shariah-based PCBs in 2020.

2.2 Descriptive Statistics

We analyse descriptive statistics about the relative efficiency of financial ratios of the commercial banking system in Bangladesh. The following table summarizes the descriptive statistics for financial ratios such as ROA, ROE, cost-income ratio, net interest margin, leverage, capital adequency ratio, non-performing loans to total loans, and coverage ratio during 2020. As can be observed, the variables have large standard deviations and their median values are almost always less than their means, indicating a right-skewed distribution.

Table 1. Descriptive statistics of financial indicators, 2020

Financial Indicators	Minimum	Mean	Maximum	Std. Dev.
Return on Assets (ROA)	0.01	0.82	3.34	0.64
Return on Equity (ROE)	0.09	10.15	26.92	6.89
Cost-Income Ratio	24.53	55.62	111.67	14.17
Net Interest Margin	-1.75	2.32	8.09	1.81
Leverage	3.00	8.09	34.40	5.61
Capital Adequency	1.26	16.56	73.00	13.33
NPL to Total Loans	0.07	5.79	31.63	6.82
Coverage Ratio	5.93	46.86	93.57	20.51

Note. Authors' Calculations.

Sources: Annual Reports from commercial Banks, Bangladesh, 2021.

3. Data and Methods

3.1 Data Sources

The secondary data was gathered from several annual reports of forty-three commercial banks, including four state-owned commercial banks (SCBs), thirty-seven private commercial banks (PCBs), including conventional PCBs of twenty-nine, Islami Shariah-based PCBs of eight, and two foreign commercial banks (FCBs) in Bangladesh for the year 2020. We use a cross-sectional dataset constructed from the balance sheets, income statements, and other financial statements of the selected forty-three DMUs. The best financial ratios of commercial banks were determined using cross-section data for Data Envelopment Analysis (DEA). Most importantly, we want to check the efficient commercial banks based on financial ratios employed in slack-based data envelopment analysis in Bangladesh, which was a remarkable year for efficiency achievement post-Basel III during the COVID-19.

3.2 Data Envelopment Analysis: A Methodological Overview

Charnes, Cooper, and Rhodes (1978) pioneered Data Envelopment Analysis (DEA). DEA is a type of non-parametric linear programming in which decision-making units (DMUs) are linearly combined to form an input-output model. It has become one of the most frequently applied methods used to assess financial organizations' efficiency (Banker et al., 1984). We

demonstrate how the suggested DEA methodology is designed in favor of or in addition to an overall ratio analysis. This can be partly due to the disparity in data availability. "Assume n commercial banks' DMUs are appraised on r financial ratios $y_{rj}(r=1,.....,s)$ and the observed r financial ratios of jth DMUs $(j=1,.....,n)$. According to Charnes, Cooper, and Rhodes (1978), the efficiency of firm 0 is given by 1/zo". The mathematical formulation of the DEA model is

$$\max \ \varphi$$

$$\text{Subject to} \ \sum_{j=1}^{n} \lambda_j y_{rj} \geq \varphi y_{ro}$$

$$\sum_{j=1}^{n} \lambda_j = 1 \ ; \ \lambda_j \geq 0$$

We describe slack-based DEA approaches based on slack that may be utilized for empirical efficient frontier estimate, as well as performance evaluation and benchmarking. The additive model is based on the DEA model with input and output slack. This DEA model is an output-focused approach in which the outputs are maximized and the inputs are assumed to be constant.

$$\max \sum_{i=1}^{m} S_i^- + \sum_{i=1}^{s} S_r^+$$

Subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = x_{i0}; i = 1,2,.....,m;$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - S_r^+ = y_{r0}; r = 1,2,.....,s;$$

$$\lambda_j, S_i^-, S_r^+ \geq 0;. j = 1,2,.....,n$$

Consider that this input and output slack-based DEA model to be nonzero. "The nonzero optimal S_i^- detects an overutilization of the ith input and the non-zero optimal S_r^+ detects a shortfall in the rth output". Clearly, the DEA model is beneficial for establishing objectives for inefficient DMUs with a priori information on output and input adjustments.

Calculations:

(i) Output Target for an inefficient DMU = Observed Output / Efficiency.

(ii) Output Slack = Output Target - Observed Output.

(iii) Output Slack Percentage = (Output Slack/ Observed Output)×100

4. Results and Discussion

We apply both ratio analysis and slack-based DEA approaches to determine the effectiveness of financial ratios that are extensively used in the commercial banking sector in Bangladesh. To be more precise, the efficiency of a bank is determined by ratios such as ROA, ROE, cost-income ratio, net interest margin, leverage, capital adequency ratio, non-performing loans to total loans, and coverage ratio. Their usage of financial statistics might make it extremely difficult to identify and compare top performers. Table 2 summarizes the efficiency results obtained by DEA using Microsoft Excel with Solver.

Table 2. Financial Ratios: DEA Analysis

DMUs	Generation (Note 2)	Output Slack %	Efficiency	Peers (Benchmarks)	Rank
State Commercial Banks (SCBs): Group-1 (n=4)					
DMU 2	1	0	1	2	1
DMU 4	1	0	1	4,37	2
DMU 3	1	2.38	0.98	2,4,7,27	14
DMU 1	1	16.27	0.86	2,10,30,33	20
Private Commercial Banks (PCBs, n=37)					
Conventional PCBs: Group-2 (n=29)					
DMU 7	3	0	1	7,17,27,30	3
DMU 10	2	0	1	10,17,32,37	4
DMU 17	4	0	1	17	5
DMU 19	1	0	1	19	6
DMU 27	4	0	1	27	7
DMU 30	2	0	1	30	8
DMU 32	1	0	1	2,10,27,42	9
DMU 33	4	0	1	33	10
DMU 12	1	9.35	0.91	2,7,33	18
DMU 24	2	10.45	0.91	4,7,30	19
DMU 21	4	16.89	0.86	2,7,33,42	21
DMU 8	1	18.00	0.85	4,10,17,27,30,32,33	22
DMU 22	4	18.21	0.85	2,10,17,32,33	23
DMU 14	4	19.24	0.84	4,7,17,27,32,33	24
DMU 11	2	20.76	0.83	4,10,17,27,30,32,33	25
DMU 23	2	20.80	0.83	2,4,30,33,36	26
DMU 13	3	21.39	0.82	4,17,27,32,33	27
DMU 31	1	21.50	0.82	2,7,10,33	28
DMU 20	2	25.87	0.79	2,4,7,10,27,30,33	29

DMU 18	2	29.31	0.77	2,7,33	30
DMU 9	2	34.36	0.74	2,7,10,27,30,33	33
DMU 29	2	34.40	0.74	2,4,7,30	34
DMU 16	4	35.12	0.74	4,17,27,32,33	35
DMU 5	1	35.59	0.74	2,4,27	36
DMU 15	2	35.68	0.74	2,32,33,37	37
DMU 25	2	38.41	0.72	2,7,27,30,33	39
DMU 28	4	40.60	0.71	2,7,27,33	40
DMU 26	1	48.35	0.67	2,27,30,33,36	42
DMU 6	2	60.08	0.62	2,30,33,36	43
Islami Shariah based PCBs: Group-3 (n=8)					
DMU 36	2	0	1	36	11
DMU 37	4	0	1	37	12
DMU 41	2	2.92	0.97	2,7,33	15
DMU 40	2	4.60	0.96	2,10,27,32	16
DMU 38	1	7.02	0.93	2,7,33	17
DMU 34	2	30.46	0.77	2,7,10,27,30,33	31
DMU 39	3	34.33	0.74	2,7,10,27,30,32,33	32
DMU 35	3	42.88	0.70	2,7,27,33	41
Foreign Commercial Banks (FCBs) : Group-4 (n=2)					
DMU 42	1	0	1	42	13
DMU 43	2	37.45	0.73	7,17,27,30,32,33	38

Note. Authors' Calculations.

Sources: Annual Reports from commercial Banks, Bangladesh, 2021.

DEA was discovered to be one of the most adaptable techniques employed in the financial sector. It allows each DMU to appear as favorable to its peers as feasible by letting each DMU select its variable weights or multipliers. DEA evaluated decision-making units' efficiency as well as simulation. In the case of Bangladesh's SCBs, PCBs, and FCBs, conventional DEA uses input-output ratios to determine the efficiency of a collection of decision-making units (DMUs). The fact that each DMU's efficiency distribution is represented by stochastic variables leads to efficiency scores that deviate from the mean efficiencies of the apparently real efficiency distributions calculated through simulation.

The majority of DEA banking studies have concentrated on commercial banks as institutions rather than on individual branches (Halkos and Salamouris, 2004). Furthermore, DEA may identify reference units for each DMU, which is a very important managerial tool because it assists in identifying potential reasons and curing inefficiencies. According to an assessment of the outcomes among Bangladesh's SCBs, PCBs, and FCBs, there are no discernible distinctions between the financial ratios. There are also no discernible distinctions between the financial ratios of conventional PCBs and Islami shariah-based PCBs. The study examines the financial ratio performance of SCBs, PCBs, and FCBs in Bangladesh. Table 2 summarizes each bank's generation, output slack percentage, efficiency score, peers of each

bank, and ranking. These findings are based on an investigation of the average slack-based DEA efficiency scores of 43 DMUs in Bangladesh.

According to Table 2, the most efficient bank is DMU_2 (Bangladesh Development Bank), which is a first generation bank. Output slack percentage is zero, efficiency score is 1 (or 100 percent), peers of each bank, and ranking is one. The result, financial ratios (as percentage) shown in appendix A3, indicates that return on assets (0.08), return on equity (0.24), cost to income ratio (91.49), net interest margin (1.60), leverage (3.44), capital adequency ratio (22.88), non-performing loans to total loans (28.01), and coverage ratio (41.58), and which measures the bank's efficiency is one by indicating the "best" financial ratios amongst the selected forty-three commercial banks in Bangladesh. On the contrary, DMU_6 (Bank Asia Limited) is the least efficient bank. This is a second generation bank. The output slack percentage is 60.08, the efficiency score is 0.62 (or 62 percent), the peers of the bank are (2, 30, 33, 36), and the ranking is 43. The financial ratios (as percentage) show that return on assets (0.53), return on equity (7.81), cost to income ratio (53.94), net interest margin (1.30), leverage (5.14), capital adequency ratio (7.16), non-performing loans to total loans (3.24), and coverage ratio (26.64), which measures the bank efficiency, is 0.62 by indicating "moderately efficient" financial ratios amongst the selected forty-three commercial banks in Bangladesh.

To calculate a bank's efficiency in terms of financial ratios, as shown in Figure 1, we employ slack-based DEA. Two SCBs (DMU_2, DMU_4), eight conventional PCBs (DMU_7, DMU_{10}, DMU_{17}, DMU_{19}, DMU_{27}, DMU_{30}, DMU_{32}, and DMU_{33}), two Islami Shariah based PCBs (DMU_{36}, DMU_{37}), and FCB (DMU_{42}) are received efficiency scores of 1 (or 100 percent). These DMUs' output slack percentage is zero. The bank efficiency score is 100 percent, indicating that thirteen DMUs are "perfectly efficient" financial ratios amongst the selected forty-three commercial banks in Bangladesh.

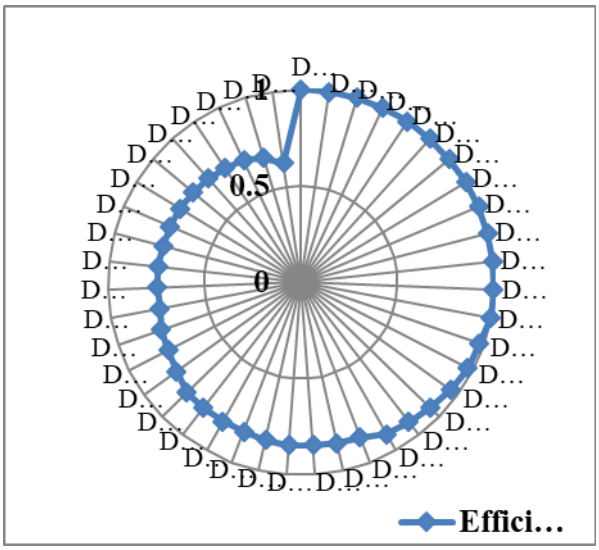


Figure 1. Efficiency Score of forty-three schedule banks

The SCB (DMU_3), two conventional PCBs (DMU_{12}, DMU_{24}), and three Islami Shariah-based PCBs (DMU_{41}, DMU_{40}, and DMU_{38}) have obtained efficiency scores ranging from 90 percent to 99 percent. The output slack percentage of these DMUs is in the single digits. Furthermore, DMU_1 is an SCB with an efficiency score of 86 percent and an output slack percentage of 16.27 percent. As for conventional PCBs, DMU_{21}'s efficiency score is 86 percent and its output slack percentage is 16.89, DMU_8's efficiency score is 85 percent and its output slack percentage is 18.00, DMU_{22}'s efficiency score is 85 percent and its output slack percentage is 18.21, DMU_{14}'s efficiency score is 84 percent and its output slack percentage is 19.24, DMU_{11}'s efficiency score is 83 percent and its output slack percentage is 20.76, DMU_{23}'s efficiency score is 83 percent and its output slack percentage is 20.80, DMU_{13}'s efficiency score is 82 percent and its output slack percentage is 21.39, and DMU_{31}'s efficiency score is 82 percent and its output slack percentage is 21.50. Thus, the bank efficiency score is from 90 percent to 100 percent by indicating that six DMUS are "highly efficient" financial ratios; and also 80 percent to 89 percent by indicating that nine DMUs are "highly efficient" financial ratios amongst the selected forty-three commercial banks in Bangladesh.

The bank efficiency score ranges from 60 percent to 79 percent by indicating that fifteen DMUs are "moderately efficient" financial ratios. In terms of conventional PCBs, DMU_{20}'s efficiency score is 79 percent and its output slack percentage is 25.87, DMU_{18}'s efficiency score is 77 percent and its output slack percentage is 29.31, DMU_9's efficiency score is 74 percent and its output slack percentage is 34.36, DMU_{29}'s efficiency score is 74 percent and its output slack percentage is 34.40, DMU_{16}'s efficiency score is 74 percent and its output slack percentage is 35.12, DMU_5's efficiency score is 74 percent and its output slack percentage is 35.59, DMU_{15}'s efficiency score is 74 percent and its output slack percentage is 35.68, DMU_{25}'s efficiency score is 72 percent and its output slack percentage is 38.41, DMU_{28}'s efficiency score is 71 percent and its output slack percentage is 40.60, DMU_{26}'s efficiency score is 67 percent and its output slack percentage is 48.35, DMU_6's efficiency score is 62 percent and its output slack percentage is 60.08.

As for conventional Islami Shariah-based PCBs, DMU_{34}'s efficiency score is 77 percent and its output slack percentage is 30.46, DMU_{39}'s efficiency score is 74 percent and its output slack percentage is 34.33, and DMU_{35}'s efficiency score is 70 percent and its output slack percentage is 42.88. On the other hand, as FCB, DMU_{43}'s efficiency score is 73 percent and its output slack percentage is 37.45. Thus, DMUs may need to maximize their return on equity in order to increase their efficiency. The efficiency scores are obtained by the use of slack-based DEA and to identify banks' peers (Bar et al., 1993; Paradi et al., 2011). The majority of the DMUs' peers are DMU_2, DMU_4, DMU_7, DMU_{10}, DMU_{17}, DMU_{19}, DMU_{27}, DMU_{30}, DMU_{32}, DMU_{33}, DMU_{36}, DMU_{37}, and DMU_{42}, and the efficiency score of those DMU's is 1.

5. Concluding Remarks

The aforementioned research demonstrates that the financial ratios of commercial banks in Bangladesh have been experimentally tested. Due to COVID-19, the secondary data was

gathered from several annual reports of forty-three commercial banks, including four state-owned commercial banks (SCBs), thirty-seven private commercial banks (PCBs), including conventional PCBs of twenty-nine and Islami Shariah-based PCBs of eight, and two foreign commercial banks (FCBs) in Bangladesh for the year 2020. This study paper examines slack-based DEA, which determines the efficiency of bank performance by analyzing cross-sectional data from published annual reports of Bangladesh's SCBs, PCBs, and FCBs (2021).

The results of DEA predicted that some banks' financial ratios would be relatively better than those of other banks in both areas (Halkos and Salamouris, 2004). In the aftermath of the GFC (Alexakis et al., 2019), and COVID-19 (Saeed et al., 2020; Safiullah & Shamsuddin, 2020), all of these products have improved their technology. We apply slack-based DEA approaches using financial ratios to determine the efficiency of a collection of decision-making units (DMUs). The effectiveness of financial ratios are ROA, ROE, cost-income ratio, net interest margin, leverage, capital adequency ratio, non-performing loans to total loans, and coverage ratio, which are extensively used in the commercial banking sector in Bangladesh.

Two SCBs (DMU_2, DMU_4), eight conventional PCBs (DMU_7, DMU_{10}, DMU_{17}, DMU_{19}, DMU_{27}, DMU_{30}, DMU_{32}, and DMU_{33}), two Islami Shariah-based PCBs (DMU_{36}, DMU_{37}), and FCB (DMU_{42}) received efficiency scores of 100 percent, indicating that thirteen DMUs are “perfectly efficient” financial ratios. Moreover, SCB (DMU_3), two conventional PCBs (DMU_{12}, DMU_{24}), and three Islami Shariah based PCBs (DMU_{41}, DMU_{40}, and DMU_{38}) obtained efficiency scores ranging from 90 percent to 99 percent, indicating that six DMUs are "highly efficient" financial ratios. DMU_1 is SCB, and nine conventional PCBs (DMU_{21}, DMU_8, DMU_{22}, DMU_{14}, DMU_{11}, DMU_{23}, DMU_{13}, and DMU_{31}) have obtained an efficiency score of 80 percent to 89 percent, indicating that nine DMUs are “highly efficient” financial ratios. Furthermore, the bank efficiency score ranges from 60 percent to 79 percent, indicating that fifteen DMUs are “moderately efficient” financial ratios amongst the selected forty-three commercial banks in Bangladesh.

The most efficient DMU is DMU_2 (Bangladesh Development Bank), which measures the bank's efficiency by indicating “best” financial ratios. Conversely, DMU_6 (Bank Asia Limited) is the least efficient bank, which measures the bank's efficiency at 0.62 by indicating “moderately efficient” financial ratios amongst the selected forty-three commercial banks in Bangladesh. The efficiency scores are obtained by the use of slack-based DEA and to identify DMUs’ peers (Barr et al., 1993; Paradi et al., 2011). The majority of DMUs’ peers include DMU_2, DMU_4, DMU_7, DMU_{10}, DMU_{17}, DMU_{19}, DMU_{27}, DMU_{30}, DMU_{32}, DMU_{33}, DMU_{36}, DMU_{37}, and DMU_{42}. It's DMU’s efficiency score is 1. Thus, the authority of commercial banks in Bangladesh should be more concentrated and policies adjusted on financial ratios to achieve the desired level of commercial banking efficiency.

As for policy implications, commercial banks should be measured using slack-based DEA analysis to determine their output target. From the findings, two SCBs (DMU_1, DMU_3), twenty seven PCBs, including twenty one conventional PCBs ($DMU_{1\text{-}6}$, $DMU_{8\text{-}9}$, $DMU_{11\text{-}16}$, DMU_{18},

DMU_{20-26}, DMU_{28-29}, DMU_{31}), and six Islami Shariah based PCBs (DMU_{34-35}, DMU_{38-41}), and FCB (DMU_{43}) among the 43 DMU financial ratios are inefficient. In this regard, inefficient DMUs can move towards the efficient frontier in order to become efficient. As a result, those DMUs with the most efficient financial ratios have the highest financial performance, and those DMUs with the least efficient financial ratios have the least financial performance. Thus, inefficient DMUs should be more regulated and policy adjusted for measuring performance and benchmarking against best practices.

Author Contributions:

The paper's three authors are as follows: Nobinkhor Kundu has written the manuscript, established the paper methodology, prepared tables and figures, conducted data analysis, and interpreted the data. Mst. Noiyan Tara assisted with the collected data from annual reports. Gazi Mohammed Mahbub has policy implications, proof of methods, and language editing of the manuscript. Gazi Mohammed Mahbub and Mst. Noiyan Tara co-authored the manuscript. All three authors have read and approved the final manuscript. The authors disclose that they have no conflicting interests.

Conflict of interest: We declare that we have no conflict of interest.

References

Ablanedo-Rosas, J. H., Gao, H., Zheng, X., Alidaee, B., & Wang, H. (2010). A study of the relative efficiency of Chinese ports: A financial ratio-based data envelopment analysis approach. *Expert Systems*, *27*(5), 349–362. https://doi.org/10.1111/j.1468-0394.2010.00552.x

Alexakis, C., Izzeldin, M., Johnes, J., & Pappas, V. (2019). Performance and productivity in Islamic and conventional banks: Evidence from the global financial crisis. *Economic Modelling*, *79*(August 2018), 1–14. https://doi.org/10.1016/j.econmod.2018.09.030

Ali, T. O., Hassan, M., & Hossain, N. (2021). The moral and political economy of the pandemic in Bangladesh: Weak states and strong societies during Covid-19. *World Development*, *137*(May 2020), 105216. https://doi.org/10.1016/j.worlddev.2020.105216

Asmild, M., Kronborg, D., Mahbub, T., & Matthews, K. (2019). The efficiency patterns of Islamic banks during the global financial crisis: The case of Bangladesh. *Quarterly Review of Economics and Finance*, *74*, 67–74. https://doi.org/10.1016/j.qref.2018.04.004

Avkiran, N. K. (2011). Association of DEA super-efficiency estimates with financial ratios: Investigating the case for Chinese banks. *Omega*, *39*(3), 323–334. https://doi.org/10.1016/j.omega.2010.08.001

Ayadi, R., Naceur, S. B., Casu, B., & Quinn, B. (2016). Does Basel compliance matter for bank performance? *Journal of Financial Stability*, *23*(September 2013), 15–32. https://doi.org/10.1016/j.jfs.2015.12.007

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science*, *30*(9), 1078–1092. https://doi.org/10.1287/mnsc.30.9.1078

Barr, R. S., Seiford, L. M., & Siems, T. F. (1993). An envelopment-analysis approach to measuring the managerial efficiency of banks. *Annals of Operations Research*, *45*(1), 1–19. https://doi.org/10.1007/BF02282039

Basel Committee on Banking Supervision. (1997). *Core Principles for Effective Banking Supervision*. Retrieved from https://www.bis.org/publ/bcbs30a.htm

Basel Committee on Banking Supervision. (1999). *Core Principles Methodology*. Retrieved from http://www.bis.org/publ/bcbs61.htm

Basel Committee on Banking Supervision. (2006). *Core Principles Methodology*. Retrieved from http://www.bis.org/Publ/Bcbs130.htm.

Basel Committee on Banking Supervision. (2012). *Core Principles for Effective Banking Supervision*. Retrieved from http://www.bis.org/publ/bcbs230.htm

Charnes, A., Cooper, W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, *2*(6), 429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Cook, W. D., Tone, K., & Zhu, J. (2014). Data envelopment analysis: Prior to choosing a model. *Omega* (United Kingdom), *44*, 1–4. https://doi.org/10.1016/j.omega.2013.09.004

Degl'Innocenti, M., Kourtzidis, S. A., Sevic, Z., & Tzeremes, N. G. (2017). Bank productivity growth and convergence in the European Union during the financial crisis. *Journal of Banking and Finance*, *75*, 184–199. https://doi.org/10.1016/j.jbankfin.2016.11.016

Dyson, R. G., Allen, R., Camanho, A. S., Podinovski, V. V., Sarrico, C. S., & Shale, E. A. (2001). Pitfalls and protocols in DEA. *European Journal of Operational Research*, *132*(2), 245–259. https://doi.org/10.1016/S0377-2217(00)00149-1

Eyceyurt Batir, T., Volkman, D. A., & Gungor, B. (2017). Determinants of bank efficiency in Turkey: Participation banks versus conventional banks. *Borsa Istanbul Review*, *17*(2), 86–96. https://doi.org/10.1016/j.bir.2017.02.003

Fang, J., Lau, C. K. M., Lu, Z., Tan, Y., & Zhang, H. (2019). Bank performance in China: A Perspective from Bank efficiency, risk-taking and market competition. *Pacific Basin Finance Journal*, *56*(February), 290–309. https://doi.org/10.1016/j.pacfin.2019.06.011

Green, R. H., & Doyle, J. R. (1997). Implementing data envelopment analysis: Primal or dual? *Infor*, *35*(1), 66–75. https://doi.org/10.1080/03155986.1997.11732319

Halkos, G. E., & Salamouris, D. S. (2004). Efficiency measurement of the Greek commercial banks with the use of financial ratios: A data development analysis approach. *Management Accounting Research*, *15*(2), 201–224. https://doi.org/10.1016/j.mar.2004.02.001

Hossain, M. R., Chakma, S., Tasnim, F., & Zahra, Z. (2021). Socio-economic predictors of public understanding of the COVID-19 pandemic. *Heliyon*, *7*(6), e07255. https://doi.org/10.1016/j.heliyon.2021.e07255

Isik, I., & Hassan, M. K. (2002). Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking and Finance*, *26*(4), 719–766. https://doi.org/10.1016/S0378-4266(01)00167-4

Kamarudin, F., Sufian, F., & Nassir, A. (2016). Global financial crisis , ownership and bank profit efficiency in the Bangladesh ' s state owned and private commercial banks. *Contaduría y Administración*, *61*(4), 705–745. https://doi.org/10.1016/j.cya.2016.07.006

Kao, C., & Liu, S. T. (2009). Stochastic data envelopment analysis in measuring the efficiency of Taiwan commercial banks. *European Journal of Operational Research*, *196*(1), 312–322. https://doi.org/10.1016/j.ejor.2008.02.023

Kundu, N., Sikdar, A., & Ahmed, H. U. (2019). Measuring Efficiency of Some Selected Commercial Banks between Canada and the UK: A Data Envelopment Analysis Approach. *Journal of Green Business School*, *2*(1), 18–37. https://green.edu.bd/wp-content/uploads/2021/05/sl4.pdf

LaPlante, A. E., & Paradi, J. C. (2015). Evaluation of bank branch growth potential using data envelopment analysis. *Omega* (United Kingdom), *52*, 33–41. https://doi.org/10.1016/j.omega.2014.10.009

Lin, Y. H., Hsu, G. J. Y., & Hsiao, C. K. (2007). Measuring efficiency of domestic banks in Taiwan: Application of data envelopment analysis and Malmquist index. Applied Economics Letters, *14*(11), 821–827. https://doi.org/10.1080/13504850600605960

Mahbub, T., Matthews, K., & Barker, K. (2019). Other people's money: The profit performance of Bangladeshi family dominated banks. *Journal of Behavioral and Experimental Finance*, *21*, 103–112. https://doi.org/10.1016/j.jbef.2018.11.005

Mobarek, A., & Kalonov, A. (2014). Comparative performance analysis between conventional and Islamic banks: Empirical evidence from OIC countries. *Applied Economics*, *46*(3), 253–270. https://doi.org/10.1080/00036846.2013.839863

Nguyen, T. P. T., Roca, E., & Sharma, P. (2014). How efficient is the banking system of Asia's next economic dragon? Evidence from rolling DEA windows. *Applied Economics*, *46*(22), 2665–2684. https://doi.org/10.1080/00036846.2014.909578

Paradi, J. C., Rouatt, S., & Zhu, H. (2011). Two-stage evaluation of bank branch efficiency using data envelopment analysis. *Omega*, *39*(1), 99–109. https://doi.org/10.1016/j.omega.2010.04.002

Paradi, J. C., & Schaffnit, C. (2004). Commercial branch performance evaluation and results communication in a Canadian bank - A DEA application. *European Journal of Operational Research*, *156*(3), 719–735. https://doi.org/10.1016/S0377-2217(03)00108-5

Paradi, J. C., Zhu, H., & Edelstein, B. (2012). Identifying managerial groups in a large Canadian bank branch network with a DEA approach. *European Journal of Operational Research*, *219*(1), 178–187. https://doi.org/10.1016/j.ejor.2011.12.022

Partovi, E., & Matousek, R. (2019). Bank efficiency and non-performing loans: Evidence from Turkey. *Research in International Business and Finance*, *48*(December 2018), 287–309. https://doi.org/10.1016/j.ribaf.2018.12.011

Robin, I., Salim, R., & Bloch, H. (2018). Cost efficiency in Bangladesh banking: does financial reform matter? *Applied Economics*, *50*(8), 891–904. https://doi.org/10.1080/00036846.2017.1346361

Robin, I., Salim, R., & Bloch, H. (2019). Financial deregulation and productivity growth in banking sector: empirical evidence from Bangladesh. *Applied Economics*, *51*(47), 5104–5121. https://doi.org/10.1080/00036846.2019.1607244

Rosman, R., Wahab, N. A., & Zainol, Z. (2014). Efficiency of Islamic banks during the financial crisis: An analysis of Middle Eastern and Asian countries. *Pacific Basin Finance Journal*, *28*, 76–90. https://doi.org/10.1016/j.pacfin.2013.11.001

Saeed, M., Izzeldin, M., Hassan, M. K., & Pappas, V. (2020). The inter-temporal relationship between risk, capital and efficiency: The case of Islamic and conventional banks. *Pacific Basin Finance Journal*, *62*(April), 101328. https://doi.org/10.1016/j.pacfin.2020.101328

Safiullah, M., & Shamsuddin, A. (2020). Technical efficiency of Islamic and conventional banks with undesirable output: Evidence from a stochastic meta-frontier directional distance function. *Global Finance Journal*, May, 100547. https://doi.org/10.1016/j.gfj.2020.100547

Sahin, G., Gokdemir, L., & Ozturk, D. (2016). Global Crisis and its Effect on Turkish Banking Sector: A Study with Data Envelopment Analysis. *Procedia Economics and Finance*, *38*(October 2015), 38–48. https://doi.org/10.1016/s2212-5671(16)30174-5

Vazquez, F., & Federico, P. (2015). Bank funding structures and risk: Evidence from the global financial crisis. *Journal of Banking and Finance*, *61*, 1–14. https://doi.org/10.1016/j.jbankfin.2015.08.023

Wang, K., Huang, W., Wu, J., & Liu, Y. N. (2014). Efficiency measures of the Chinese commercial banking system using an additive two-stage DEA. *Omega* (United Kingdom), *44*, 5–20. https://doi.org/10.1016/j.omega.2013.09.005

WHO. (2021). *Coronavirus disease (COVID-19 2019) Situation report*. Retrieved July 24, 2021, from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports

Yu, M. M., Lin, C. I., Chen, K. C., & Chen, L. H. (2021). Measuring Taiwanese bank performance: A two-system dynamic network data envelopment analysis approach. *Omega* (United Kingdom), *98*, 102145. https://doi.org/10.1016/j.omega.2019.102145

Zahedi-Seresht, M., Khosravi, S., Jablonsky, J., & Zykova, P. (2021). A data envelopment analysis model for performance evaluation and ranking of DMUs with alternative scenarios. *Computers and Industrial Engineering*, *152*(December 2018), 107002. https://doi.org/10.1016/j.cie.2020.107002

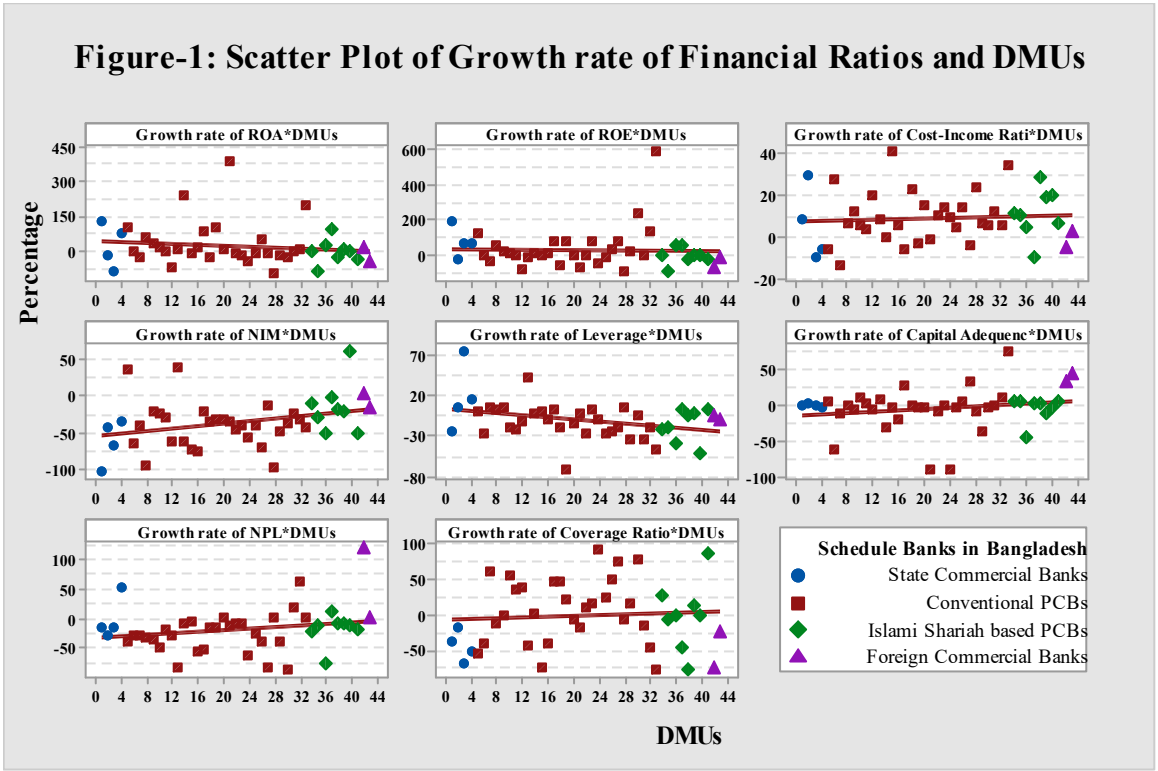
Notes

Note 1. According to the Basel Committee (1997, 1999, 2006, & 2012), 'Basel-I was effective from 1988 to 2006, and the Basel banking regulatory committee established a new variable market risk in 1998. Following the global financial crisis of 2008, the majority of banks implemented Basel-II between 2007 and 2012, which included a new operational risk variable. Beyond that, between 2013 and 2019, Basel-III was implemented, introducing new variables such as liquidity risk, leverage, additional tier-1 capital, capital conservation buffer, and countercyclical buffer'.

Note 2. Note that 1st generation banks mentioned which banks had been established up to 1990. 2nd generation banks mentioned that those banks had been established from 1991 to 2000. 3rd generation banks mentioned those banks' having been established from 2001 to 2010. 4th generation banks mentioned that those banks had been established from 2011 to 2020.

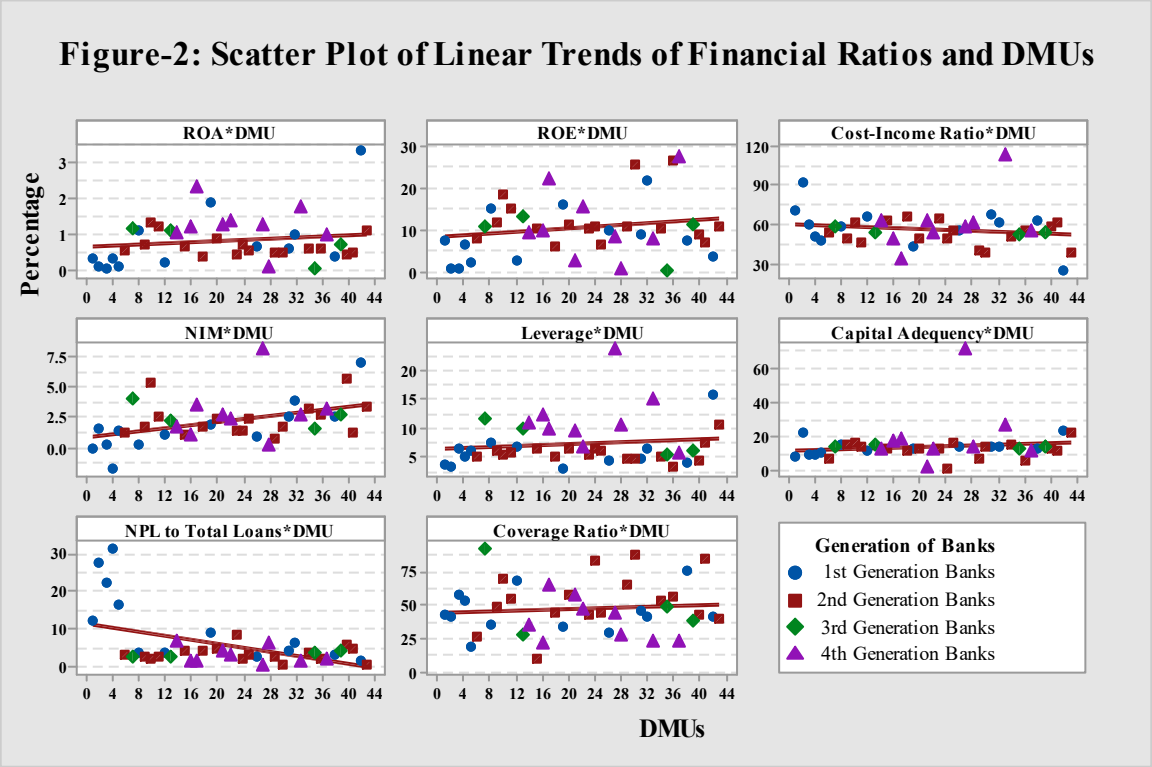
Appendix A1

Figure of Growth Rate of Financial Ratios



Appendix A2

Scatter Plot of Linear Trends of Financial Ratios



Appendix A3

Financial Ratios of DMU's

DMUs	ROA	ROE	Cost-In come Ratio	NIM	Leverage	Capital Adequenc y	NPL to Total Loans	Coverage Ratio
DMU 1	0.29	7.38	70.29	0.00	3.85	9.02	12.46	43.25
DMU 2	0.08	0.24	91.49	1.60	3.44	22.88	28.01	41.58
DMU 3	0.01	0.28	59.58	0.27	6.69	10.05	22.69	59.28
DMU 4	0.34	6.24	49.79	-1.75	5.38	10.02	31.63	53.59
DMU 5	0.10	1.65	46.76	1.51	6.35	10.84	16.79	19.41
DMU 6	0.53	7.81	53.94	1.30	5.14	7.16	3.24	26.64
DMU 7	1.18	10.58	58.06	4.17	11.81	14.55	2.93	93.57
DMU 8	1.10	14.80	57.94	0.31	7.53	15.50	4.05	36.25
DMU 9	0.70	11.28	48.78	1.87	6.36	15.48	3.13	49.62
DMU 10	1.30	18.40	61.07	5.38	5.71	17.23	2.29	70.93
DMU 11	1.22	15.04	45.58	2.59	5.97	15.23	2.72	55.15

DMU 12	0.20	2.30	65.57	1.10	6.94	12.24	3.97	68.63
DMU 13	1.10	12.93	53.14	2.31	10.00	15.50	2.95	28.05
DMU 14	0.98	8.80	60.46	1.71	10.83	12.50	6.80	34.66
DMU 15	0.67	10.05	62.56	1.07	6.68	13.61	4.72	10.52
DMU 16	1.13	8.96	47.51	1.05	12.06	17.44	1.16	20.30
DMU 17	2.28	21.70	31.06	3.50	9.62	17.84	1.22	64.83
DMU 18	0.37	5.83	65.33	1.88	5.07	12.92	4.67	44.54
DMU 19	1.90	15.96	43.14	2.01	3.00	13.00	9.38	35.08
DMU 20	0.87	11.10	48.20	2.43	6.53	13.21	4.98	57.98
DMU 21	1.22	1.64	61.06	2.56	9.29	1.60	3.71	56.86
DMU 22	1.30	14.93	51.30	2.27	6.69	12.52	2.93	46.93
DMU 23	0.44	10.28	63.43	1.54	5.58	13.02	8.60	42.95
DMU 24	0.72	10.62	48.52	1.50	6.46	1.26	2.51	84.40
DMU 25	0.54	6.31	54.88	2.40	6.22	17.27	3.46	45.77
DMU 26	0.65	9.46	54.27	0.91	4.56	14.73	2.73	30.46
DMU 27	1.20	7.42	56.95	8.09	23.59	71.10	0.07	43.00
DMU 28	0.01	0.11	59.14	0.19	10.53	13.45	6.22	26.89
DMU 29	0.47	10.33	39.76	0.75	4.85	7.30	3.10	66.73
DMU 30	0.50	25.71	37.89	1.87	4.80	14.24	0.73	89.22
DMU 31	0.61	8.42	66.53	2.70	4.87	14.91	4.35	47.30
DMU 32	0.96	21.40	60.59	3.94	6.62	14.73	6.36	41.66
DMU 33	1.69	6.98	111.67	2.64	14.82	26.68	1.04	23.06
DMU 34	0.61	10.10	49.82	3.23	5.08	15.48	3.88	54.69
DMU 35	0.06	0.09	51.87	1.61	5.43	13.27	3.81	49.61
DMU 36	0.60	26.48	53.99	2.73	3.65	6.29	2.30	56.46
DMU 37	0.91	26.92	53.53	3.19	5.54	10.65	2.03	23.18
DMU 38	0.35	7.38	62.73	2.66	4.35	13.55	3.41	75.99
DMU 39	0.68	11.08	53.50	2.86	6.12	14.19	4.57	38.34
DMU 40	0.42	8.78	58.10	5.77	4.69	13.50	6.05	42.92
DMU 41	0.49	6.45	60.13	1.35	7.65	12.86	4.92	85.35
DMU 42	3.34	3.37	24.54	7.03	15.84	24.35	1.62	42.68
DMU 43	1.12	10.77	37.47	3.52	10.92	23.21	0.61	40.23

Sources: Annual Reports from commercial Banks, Bangladesh, 2021.

Appendix A3

List of Selected Commercial Banks

S.N.	Banks Name	DMUs	Generation
State Commercial Banks (SCBs): Group-1			
1	Agrani Bank Limited	DMU 1	1
2	Bangladesh Development Bank	DMU 2	1
3	Janata Bank Limited	DMU 3	1
4	Sonali Bank Limited	DMU 4	1
Private Commercial Banks (PCBs)			
Conventional PCBs: Group-2			
1	AB Bank Limited	DMU 5	1
2	Bank Asia Limited	DMU 6	2
3	BRAC Bank Limited	DMU 7	3
4	City Bank Limited	DMU 8	1
5	Dhaka Bank Limited	DMU 9	2
6	Dutch-Bangla Bank Limited	DMU 10	2
7	Eastern Bank Limited	DMU 11	2
8	IFIC Bank Limited	DMU 12	1
9	Jamuna Bank Limited	DMU 13	3
10	Meghna Bank Limited	DMU 14	4
11	Mercantile Bank Limited	DMU 15	2
12	Midland Bank Limited	DMU 16	4
13	Modhumoti Bank Limited	DMU 17	4
14	Mutual Trust Bank Limited	DMU 18	2
15	National Bank Limited	DMU 19	1
16	NCC Bank Limited	DMU 20	2
17	NRB Bank Limited	DMU 21	4
18	NRB Commercial Bank Ltd	DMU 22	4
19	One Bank Limited	DMU 23	2
20	Premier Bank Limited	DMU 24	2
21	Prime Bank Limited	DMU 25	2
22	Pubali Bank Limited	DMU 26	1
23	Shimanto Bank Ltd	DMU 27	4
24	South Ban Agri and Com B Ltd	DMU 28	4
25	Southeast Bank Limited	DMU 29	2
26	Trust Bank Limited	DMU 30	2
27	United Commercial Bank Ltd	DMU 31	1
28	Uttara Bank Limited	DMU 32	1
29	Community Bank Bangladesh Ltd	DMU 33	4

Islami Shariah based PCBs: Group-3			
1	Al Arafah Islami Bank Limited	DMU 34	2
2	EXIM Bank Limited	DMU 35	3
3	First Security Islami Bank Limited	DMU 36	2
4	Global Islamic Bank Ltd	DMU 37	4
5	Islami Bank Bangladesh Limited	DMU 38	1
6	Shahjalal Islami Bank Limited	DMU 39	3
7	Social Islami Bank Limited	DMU 40	2
8	Standard Bank Limited	DMU 41	2
Foreign Commercial Banks (FCBs) : Group-4			
1	Standard Charterted Bank	DMU 42	1
2	HSBC	DMU 43	2