

# Measuring and Comparing Technical, Allocative and Cost Efficiency of Islamic and Conventional Commercial Banks in Bangladesh Applying Data Envelopment Analysis (DEA)

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## Abstract

*The current study aims to measure and compare the technical, allocative and cost efficiency of Islamic and conventional commercial banks operating in Bangladesh during 2017-2022. It applies data envelopment analysis (DEA) technique to estimate efficiency of 19 commercial banks which include five Islamic banks, four state-owned banks and ten conventional private commercial banks. Islamic banks showed better efficiency performance against conventional state-owned and private commercial banks. The mean technical, allocative and cost efficiency scores were 0.990, 0.797 and 0.789 for Islamic commercial banks. In contrast, the mean technical, allocative and cost efficiency scores were 0.705, 0.536 and 0.398 for the conventional state-owned commercial banks and the scores were 0.964, 0.759 and 0.735 for conventional private commercial banks. The empirical results also show that the mean technical, allocative and cost efficiency scores of all commercial banks are 0.886, 0.698 and 0.641 respectively implying that all banks showed mean technical, allocative and cost inefficiency scores of 0.114, 0.302 and 0.359 respectively. The findings suggest that there is room for improvement of cost efficiency by enhancing both technical and allocative efficiency. To this end, bank management need to adopt measures for promoting managerial efficiency (technical efficiency) and using inputs in optimal proportion given their respective prices (allocative efficiency).*

**Keywords:** Cost Efficiency, Data Envelopment Analysis, Commercial Banks, Bangladesh

**JEL Classification Code:** C14, C61, G21, G28

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## 1. Introduction

Bangladesh banking system comprising Islamic and conventional commercial banks plays dominating roles in mobilizing savings and financing key sectors in the economy due to poor performance of capital market. Commercial banks have also more potential to play greater roles in accelerating saving-investment process of the country aiming at higher growth, employment generation and poverty alleviation. A growing number of studies also reveal strong association between financial and economic growth (Roubini N & Sala-i-Martin X, 1992; King and Levine 1993a,b; Hasan, R., & Barua, S., 2015). Better functioning commercial banks can promote GDP by allocating financial resources efficiently among competing economic agents (Beck, T., & Levine, R. 2004 and Sufian, F. 2014). In contrast, poor performing banks increase the chances of failure creating financial crisis and posing serious threat to the entire financial stability (Dell'Ariccia, G., Detragiache, E., & Rajan, R. 2008; Reinhart, C. M., & Rogoff, K. S. 2013).

Bangladesh economy depends on bank led finance heavily compared to capital market financing. The ratio of private sector's bank financing to GDP is 38.80% in 2022 while the ratio of market capitalization to GDP is 19.14% at the end of December, 2022 (World Bank, 2022; Bangladesh Bank, 2022b). As bank financing is the key source of financing in Bangladesh, evaluation of bank efficiency bears immense significance in accelerating saving-investment process towards inclusive growth, smoothing monetary transmission mechanisms and enhancing financial stability. Proper evaluation of banking performance in Bangladesh with sophisticated methods can offer necessary information on level of efficiency to regulators, managers, investors and customers to undertake prudent decisions.

Bangladesh Bank (BB), being the regulatory authority regulates and monitors the activities of all the scheduled banks and financial institutions (FIs). Currently, there are 6 state-owned commercial banks (SCBs), 3 specialized development banks (SBs), 43 domestic private commercial banks, 9 foreign commercial banks (FCBs), and 35 financial institutions (FIs) operating in Bangladesh (FSR, 2021). Among 58 commercial banks, 10 private commercial banks (PCBs) have been functioning as full-fledged Islamic Banks at the end of December 2022 (Bangladesh Bank, 2022c). The 10 private commercial banks offer Shariah compliant financial services with the aid of 1659 branches. In addition, 23 Islamic banking branches of 11 conventional commercial banks and 535 Islamic banking windows of 13 conventional commercial banks also provide Islamic financial services in Bangladesh. Islamic banks accounts for 25.81 percent share in terms of deposits and 29.20 percent share in terms of investments in the total banking industry at the end of December 2022 (Bangladesh Bank, 2022c). List of full-fledged Islamic Banks and Islamic banking branches and windows of conventional banks are shown in Appendix I.

There is plethora of studies on conventional and Islamic banks in developed, emerging and developing countries (Fethi, M. D., & Pasiouras, F., 2010; Bhatia, V., Basu, S., Mitra, S. K., & Dash, P., 2018; Hassan, M. K., & Aliyu, S., 2018; Narayan, P. K., & Phan, D. H. B., 2019; Tuan, L. T. D., 2020). Only few studies are found on conventional and Islamic bank

performance in Bangladesh (Rahman, M.M., 2011; Sufian, F., and F. Kamarudin. 2013; Hoque, M.R., and M.I. Rayhan. 2013; Abduh, M., Hasan, S. M., & Pananjung, A. G., 2013; Islam, S., & Kassim, S., 2015; Banna, H., R. Ahmad, and E.H. Koh. 2017; Rashid, M. H. U., et al., 2020). Against this perspective, the present study has been undertaken to examine the efficiency performance of both Islamic and conventional banks operating in Bangladesh. The current study would empirically measure and compare the cost efficiency of Bangladeshi Islamic and conventional commercial banks by using non-parametric Data Envelopment Analysis (DEA) over the period of 2017-2022.

The broad objective of the research project is two-fold: first, to examine and compare cost efficiency of commercial banks in Bangladesh over the period from 2017 to 2022. More specific objectives of the study project will be:

- (a) to measure cost, technical and allocative efficiency of Islamic and conventional commercial banks in Bangladesh during the period of 2017 to 2022;
- (b) to compare efficiency between Islamic and conventional commercial banks in Bangladesh during the period under study;
- (c) to assess efficiency of Islamic and conventional commercial banks in Bangladesh before, during and after Covid 19 pandemic.
- (d) to provide policy prescriptions for improvement of efficiency of commercial banks in Bangladesh;

The remaining portion of the paper has been organized as follows: introduction, the second section deals with review of literature; the third section focuses on methodology; the fourth section analyses findings and finally, the fifth section concludes with policy directions.

## **2. Literature Review**

This section sheds lights on concepts of banking efficiency and some empirical studies on banking performance related to different countries particularly Bangladesh.

### **2.1 Measuring Performance of Bank**

Bank performance can be viewed from the perspective of productivity, efficiency, competition, profitability and concentration (Bikker & Bos, 2008). According to leading Finance authors Rose & Hudgins (2013) bank performance can be defined as how fairly well a bank can satisfy the demands of various stakeholders including depositors, investors and shareholders. The writers also think that bank performance should be measured against its specific objectives and accordingly, commercial bank sets maximization of profit for shareholders and depositors as its prime objective.

In evaluating bank performance, the 'efficiency' concept of firm derived from production function in microeconomics has been widely used in many quality studies/papers (Berger and Humphrey (1997). Following this tradition, Hassan, K., M (2006) define bank efficiency as the relative performance of a bank given its inputs or outputs compared to

other banks with the same input or output limitations. In its basic output context, 'efficiency' measures the given output from a firm using a given input of resources. The most efficient bank produces maximum output from a given set of inputs. The most efficient bank will score 1 (or 100 per cent) while the most inefficient bank will score zero (0 percent). Inefficiency arises when a bank attains score of less than one.

Inspired by the pioneering work of Debreu (1951) and Koopmans (1951), Farrell (1957) introduced modern efficiency measurement based on the efficient frontier. He defined a simple measure of firm efficiency that could account for multiple inputs and he proposed that efficiency of any firm consists of two components: technical efficiency (TE) and allocative efficiency (AE). TE denotes the ability of the firm to maximize outputs from the given set of inputs while AE indicates the ability of the firm to use inputs in optimal proportion given their respective prices. Combining these two measures provides a measure of total economic or cost efficiency (Collie T. J, 1996).

A cost efficiency measure provides how close a bank's cost is to what a best-practice bank's cost would be for producing the same bundle of outputs (Weill 2004). If the objective of the production unit is cost minimization, then a measure of cost efficiency is provided by the ratio of minimum cost to observed cost (Lovell 1993). The cost efficiency has two distinct and separable components-technical efficiency (TE) and allocative efficiency (AE). The product of technical and allocative efficiency provides cost efficiency and one can calculate cost efficiency as  $CE = TE \times AE$ .

## 2.2 Empirical Papers/Studies

Here, we analyze some key papers/studies on bank's cost efficiency based on data envelopment analysis, as we will employ DEA to measure and compare cost efficiency of commercial banks in Bangladesh.

Sufian, F. (2011) critically examines the sources of inefficiency in the Korean banking sector over the period 1992-2003 employing data envelopment analysis. The DEA method allows for the decomposition of technical efficiency (TE) into its mutually exhaustive components of pure technical and scale efficiencies. The empirical findings suggest that estimates of TE are consistently higher under an operating approach vis-a-vis the intermediation and value-added approaches. On the other hand, banks are characterized by a relatively low level of TE under the intermediation approach.

Ab-Rahim, R., et al., (2012) estimates the cost efficiency and its decompositions of Malaysian banks over the period of 1995 to 2010 by utilizing data envelopment analysis (DEA). Tobit regression analysis is also undertaken to identify the determinants of various measures of banking efficiency. The results indicate that government ownership, population density, demand density and market concentration are positively associated with several measures of efficiency while macroeconomic condition, capitalization, credit risk, asset quality and management quality have negative relationship with various

measures of efficiency. However, the size of banks is found to have mixed sign, positive coefficient with technical and pure technical efficiency while the negative relationship with scale efficiency, cost and allocative efficiency.

Raina, D., & Kumar Sharma, S. (2013) examines the cost efficiency of Indian commercial banks using Data Envelopment Analysis (DEA) over the period of 2005-06 to 2010-11. In consistent with the earlier findings, the results show that there is substantial inefficiency among the commercial banks in India over the period of the study. This result suggests that the observed cost inefficiency in the Indian banking industry is primarily due to the regulatory environment in which public sector banks are operating rather than the managerial problems in using the financial resources. The results further signify that the level of competitive practices and technology in the Indian banking industry during the post-reforms period served as a catalyst in improving the level of cost efficiency.

Islam, S., and Kassim, S. (2015) apply data envelopment analysis (DEA) in order to compare the efficiency between Islamic and conventional banks in Bangladesh during 2009-2013. The empirical results show that average technical efficiency score of Islamic banks and conventional bank is 0.965 and 0.976 respectively. Regarding sources of inefficiency of Islamic banks, the findings reveal that scale inefficiency is the main source of technical inefficiency rather than pure technical inefficiency. In contrast, technical inefficiency of conventional banks is mainly due to pure technical inefficiency rather their scale inefficiency.

Rahman, M. Mizanur & Sohel, M. Nurul Islam (2018) use Data Envelopment Analysis (DEA) in measuring the operational efficiency of the banking sector in Bangladesh during 2013 to 2017. The DEA results show that Islamic banks are slightly more efficient than conventional private banks and public conventional banks are the least efficient. The returns to scale estimation show that both conventional and Islamic banks in Bangladesh have still scope of improvement in scale efficiency. Second stage regression results indicate that Return on Asset (ROA) has significant contribution on efficiency level of the private commercial banks. It is also revealed that first-generation banks are efficient over second, third and fourth generation banks; while second generation banks are better than third and fourth generation banks.

Liu, R. (2019) applies both the Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to examine and compare cost efficiencies of US and Canadian commercial banks during 2008-2017. The results regarding cost and profit efficiency conform to prior studies indicating a relatively low correlation. However, SFA and DEA produce very different and uncorrelated results, though DEA generates overall lower efficiencies, as expected. Thus, the findings suggest that methodology cross-checking along with information regarding variables selection is necessary before decision making.

Fagge, A. (2019) investigates the consistency of technical, allocative and cost efficiency of

deposit money banks in Nigeria over the period 2010 to 2017 using data envelopment analysis (DEA). The results show that the average technical, allocative and cost efficiency scores of the banking sector for the period under review are 80.6, 89.5 and 81.7 per cent respectively. It indicates that on average, bank could have used 19.4 per cent less resources, if it had used the method adopted by the most efficient bank.

Sang, M. (2022) analyzes the impact of COVID-19 on the efficiency of 26 Vietnamese commercial banks using data envelopment analysis (DEA) approach. Research findings reveal that Vietnamese commercial banks have effectively leveraged the impacts of the COVID-19 pandemic, since the average efficiency in 2020 improved over the pre-pandemic period in 2019.

Gulati, R., et al., (2023) estimate banks' deposits-generating and operating efficiencies using a two-stage directional distance function-based network data envelopment analysis (DDF-NDEA) approach and aims to capture the immediate impact of COVID-19 on these efficiency measures by comparing their magnitudes in the pre-pandemic (2014/15–2019/20), just 1-year prior to the pandemic (2019/20), and during the pandemic year (2020/21) periods. Findings show that the Indian banking system was resilient and withstood the immediate impact of the COVID-19 pandemic. Large and medium-sized banks experienced some efficiency losses in their operating performance.

### 3. Methodology

There are two main methods to measure efficiency of commercial banks namely financial ratios analysis approach and frontier analysis approach.

Under financial ratio analysis approach, different financial ratios are used to examine various aspects of banks performance. Yue (1992) mentions that though the financial ratio analysis (FRA) approach is popular for its simplicity, easy understanding and user friendliness, it suffers from some limitations. Simple financial ratios cannot be reduced to a single measure that can cover the multi-faceted bank operations. As banks use multiple inputs and produce multiple outputs, this method becomes insufficient to measure efficiency of commercial banks properly.

In contrast, under frontier analysis approach efficiency of bank is measured relative to a "best practice" frontier (production/cost function). Under the frontier analysis, various approaches use different techniques to envelop the observed data and make different accommodations for random noise and for the flexibility in the structure of the production technology (Lovell 1993). This approach is considered better as it can control differences among firms in a sophisticated multidimensional framework that has its roots in economic theory (Cummins and Weiss, 2000). Berger and Humphrey (1997) also support the frontier approach as it provides an overall, objectively determined, numerical efficiency value and ranking of firms. There are two methods to measure efficiency of bank under the frontier analysis approach such as parametric (econometric) and non-parametric (linear

programming based) methods.

Aigner et al., (1977) and Meusen and Van Den Broeck, (1977) developed the stochastic frontier analysis (SFA) as the most popular tool among parametric (econometric) methods. The stochastic frontier analysis (SFA) is used to estimate cost or production functions. It has an advantage of computing efficiency scores in multiple-inputs and multiple-outputs production setting such as banking firm with inclusion of distribution of the inefficiency and environmental variables in the model.

Charnes et al. (1978) proposed data envelopment analysis (DEA) and it is the most widely used techniques among non-parametric (linear programming-based) methods in measuring efficiency of banks. DEA is a methodology oriented on the frontiers instead of the central tendencies: it determines a linear surface on the top of observations. It is also a linear programming technique where the set of best-practice or frontier observations are those for which no other decision-making unit or linear combination of units has as much or more of every output (given inputs) or as little or less of every input (given outputs). The DEA frontier is formed as the piecewise linear combinations that connect the set of these best-practice observations, yielding convex production possibilities set. As such, DEA does not require the explicit specification of the form of the underlying production relationship.

DEA developed by Charnes et al. (1978) employed a mathematical planning program to measure the technical efficiency under constant returns-to-scale. This type of DEA model is known as Charnes–Cooper–Rhodes (CCR) model. Later, Banker et al. (1984) developed a revised model including variable returns-to-scale, thus allowing the computation of pure technical efficiency and scale efficiency which is called Banker–Charnes–Cooper (BCC) Model.

The present paper employs data envelopment analysis (DEA) in measuring cost efficiency of commercial banks in Bangladesh due to its applicability with small sample size and limitations of financial ratios analysis approach and the stochastic frontier analysis (SFA). DEA has an advantage of computing efficiency scores in multiple-inputs and multiple-outputs production setting without specifying any functional form and distribution of the inefficiency term as required by the stochastic frontier analysis (SFA).

### **3.1 Data Envelopment Analysis (DEA) Method: Model Specification**

The present paper uses data envelopment analysis (DEA) under CCR model to estimate cost, technical and allocative efficiency of commercial banks in Bangladesh. DEA has three steps (Kumar, S., 2013).

The first step is to obtain a measure of TE. Let us consider  $N$  banks each producing  $M$  different outputs using  $K$  different inputs. The  $K \times N$  input matrix,  $X$ , and the  $M \times N$  output matrix,  $Y$ , represent the data of all  $N$  banks, while for the individual bank these are represented by the vectors  $x_i$  and  $y_i$ . The input-oriented measure of technical efficiency for

a particular bank is calculated as:

$$\begin{aligned} & \min \theta, \lambda \\ & st -y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & \lambda \geq 0(i) \end{aligned}$$

where  $\theta$  is the scalar and  $\lambda$  is a  $N \times 1$  vector of constants. The value of  $\theta$  indicates technical efficiency score for a particular bank where  $0 \leq \theta \leq 1$ . In case  $\theta$  has value equal to 1 the bank lies on the frontier and is fully efficient while when  $\theta < 1$ , the bank is a relatively inefficient one.

The second step is to estimate cost efficiency of banks. If economic objective function aims to cost minimization and price information is available, DEA can be used to measure cost efficiency. We can write the cost minimization DEA model as:

$$\begin{aligned} & \min \lambda, x_i^* w_i^* x_i^* \\ & st \quad -y_i + Y\lambda \\ & \quad x_i^* - X\lambda \\ & \quad N1^T \lambda = 1 \\ & \quad \lambda (ii) \end{aligned}$$

where  $w_i$  is a vector of input price of  $i$ -th bank and  $x^*$  is cost minimization vector of input quantities for the  $i$ -th bank, given the input prices  $w_i$  and output levels  $y_i$ . The total cost efficiency (CE) or economic efficiency of  $i$ -th bank can be defined as

$$CE = w_i^T x_i^* / w_i^T x_i \dots \dots \dots (iii)$$

This indicates that CE refers to the ratio of minimum costs to observed costs.

The third step is to obtain a measure of AE. Since product of technical and allocative efficiency provides cost efficiency, one can calculate allocative efficiency residually as the ratio of the measure of cost efficiency to the Farrell input-oriented measure of technical efficiency. Thus, a measure of allocative efficiency for bank  $i$  is obtained as

$$AE = CE / TE \dots \dots \dots (iv)$$

### 3.2 Specification of Input and Output variables

In order to employ DEA approach, it is essential to define relevant input and output variables when measuring the efficiency of banks (Berger and Mester, 1997). Major bank studies use either production or intermediation approach.

My paper adopts the intermediation approach to select variables that has widely been used in bank studies (Hassan, M.K., 2006 and Islam, S., & Kassim, S., 2015). The

intermediation approach is suitable for banking study as banks intermediate between savers and investors by transforming deposits into earning assets, rather than as producers of services and loans.

The paper select three inputs and three outputs for the model. The input vectors include (a) deposits, (b) fixed assets and (c) labor. We measure deposits by the sum of demand and time deposits, fixed assets by costs on premises and labor by staff costs.

On the other hand, the output vector includes (a) total loans; (b) other earning assets (funds used in corporate and Government securities) and (c) off-balance sheet activities (Acceptances and endorsements, Letters of guarantee, Irrevocable letters of credit, Bills for collection).

The unit price of deposits is derived by dividing profits/interests by total deposits while calculating unit price of fixed assets by dividing expenditures on premises including other fixed assets by total fixed assets. By dividing total staff costs by the number of staff determines the unit cost of staff.

All variables are measured in millions of BDT (Bangladesh currency Unit, Taka).

### 3.3 Sample Size and Data

My empirical analysis is based on a sample of 19 commercial banks in Bangladesh, which includes 4 state-owned commercial banks, 10 domestic private conventional commercial banks and 5 Islamic commercial banks. The four state-owned banks cover 91% assets among state-owned banks, 10 domestic private banks cover 54% assets among private banks and 5 Islamic commercial banks cover 84% assets among Islamic banks. The 19 banks in the sample cover over 65% assets of the entire banking industry in Bangladesh which is well representative of the banking industry in Bangladesh. List of sample banks is shown in Appendix. II

The study uses balanced panel data of selected banks collected from their annual reports during 2017-2022 for measuring and comparing cost efficiency performance of commercial banks in Bangladesh. The DEAP version 2.1 program developed by Coelli, T. (1996) is used to compute efficiency applying data envelopment analysis.

## 4. Findings and Discussions

This section analyses and compares cost efficiency of different types of Commercial Banks in Bangladesh during the study period of 2017 to 2022. A 100 percent efficient bank attains score 1 (one) and bank with score less than 1 (one) is treated as inefficient bank. The more the score less than one, the higher will be inefficiency.

### 4.1 Efficiency of Islamic Private Commercial Banks

Table-4.1 depicts trend of cost efficiency of sample Islamic commercial banks during 2017- 2022. Among Islamic banks in the sample, Islami Bank Bangladesh Limited, the largest Islamic Bank secured mean technical, allocative and costefficiency scores of

**Table 4.1: Efficiency of Islamic Commercial Banks (ICBs)**

Bank	Efficiency	2017	2018	2019	2020	2021	2022	Mean
IBBL	TE	0.891	1.000	1.000	0.925	1.000	1.000	0.969
	AE	0.921	0.980	1.000	0.875	0.934	1.000	0.952
	CE	0.821	0.980	1.000	0.809	0.934	1.000	0.924
AAIBL	TE	0.931	0.978	1.000	1.000	1.000	1.000	0.985
	AE	0.889	0.766	0.762	0.572	0.642	0.679	0.718
	CE	0.827	0.750	0.762	0.572	0.642	0.679	0.705
SIBL	TE	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	AE	0.889	1.000	1.000	1.000	1.000	1.000	0.982
	CE	0.889	1.000	1.000	1.000	1.000	1.000	0.982
EXIM	TE	1.000	1.000	0.983	1.000	1.000	1.000	0.997
	AE	0.882	0.736	0.717	0.759	0.853	0.558	0.751
	CE	0.882	0.736	0.704	0.759	0.853	0.558	0.749
SJIB	TE	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	AE	1.000	0.5700	0.531	0.477	0.401	0.527	0.584
	CE	1.000	0.5700	0.531	0.477	0.401	0.527	0.584
Mean	TE	0.96	1.00	0.997	0.985	1.000	1.000	0.990
	AE	0.92	0.81	0.802	0.737	0.766	0.753	0.797
	CE	0.88	0.81	0.799	0.723	0.766	0.753	0.789

Source: Author's Calculation based on DEA

0.969, 0.952, and 0.924 respectively during 2017-2022. Al Arafah Islami Bank Limited attained mean technical, allocative and cost efficiency scores of 0.985, 0.718, and 0.705 respectively. The mean technical, allocative and cost efficiency scores were 1.000, 0.982 and 0.982 for SIBL, 0.997, 0.751, and 0.749 for EXIM bank and 1.000, 0.584 and 0.584 for Shahjalal Islami bank. All Islamic Banks face mean technical, allocative and cost efficiency scores of 0.990, 0.797, and 0.789 respectively during the study period. It implies that all Islamic banks could use 21.1 percent less resources (cost inefficiency) to produce the present level output.

#### 4.2 Efficiency of State-Owned Commercial Banks (SCBs)

Table 4.2 shows efficiency scores of State-owned Commercial Banks (SCBs). Sonali Bank, the largest bank in Bangladesh secured mean technical, allocative and cost efficiency scores of 0.556, 0.371 and 0.264 respectively during 2017-2022. The mean technical, allocative and cost efficiency scores were 0.875, 0.559 and 0.500 for Janata bank, 0.680, 0.554 and 0.393 for Agrani bank and 0.711, 0.662, and 0.436 for Rupali bank during the period under review. All State-Owned commercial banks attained mean technical, allocative and cost efficiency scores of 0.705, 0.536, and 0.398 respectively during the study period. It implies that all state-owned commercial banks could save 60.19 percent resources (avoiding cost inefficiency) to produce the present level output.

**Table 4.2: Efficiency of State-owned Commercial Banks (SCBs)**

NCBs	Efficiency	2017	2018	2019	2020	2021	2022	Mean
SB	TE	1.000	0.377	0.475	0.442	0.495	0.546	0.556
	AE	1.000	0.226	0.196	0.214	0.281	0.311	0.371
	CE	1.000	0.085	0.093	0.094	0.139	0.170	0.264
JB	TE	1.000	0.942	0.888	0.771	0.829	0.820	0.875
	AE	0.888	0.582	0.521	0.421	0.466	0.474	0.559
	CE	0.888	0.549	0.463	0.325	0.386	0.389	0.500
AB	TE	0.962	0.596	0.672	0.553	0.578	0.716	0.680
	AE	0.850	0.602	0.517	0.429	0.457	0.466	0.554
	CE	0.818	0.359	0.348	0.237	0.264	0.333	0.393
RB	TE	0.799	0.598	0.740	0.634	0.789	0.703	0.711
	AE	0.825	0.812	0.740	0.578	0.420	0.595	0.662
	CE	0.660	0.486	0.353	0.366	0.331	0.418	0.436
Mean	TE	0.940	0.628	0.694	0.600	0.673	0.696	0.705
	AE	0.891	0.556	0.494	0.411	0.406	0.462	0.536
	CE	0.842	0.370	0.314	0.256	0.280	0.328	0.398

Source: Author's Calculation based on DEA

### 4.3 Efficiency of Conventional Private Commercial Banks (CPCBs)

Table-4.3 depicts cost efficiency of private conventional commercial banks during the study period. The mean technical, allocative and cost efficiency scores were 0.863, 0.676, and 0.604 for Pubali bank, 1.000, 0.942, and 0.942 for AB Bank and 1.000, 0.882 and 0.882 for NBL during the period under review. The mean technical, allocative and cost efficiency scores were 0.997, 0.659, and 0.656 for City Bank, 0.991, 0.991 and 0.983 for IFIC and 0.964, 0.517 and 0.492 for UCBL during the period under review. The mean technical, allocative and cost efficiency scores were 0.894, 0.865, and 0.775 for DBBL, 1.000, 0.647 and 0.647 for Prime, 0.953, 0.639 and 0.611 for Southeast and 0.977, 0.776 and 0.756 for Brac Bank. All private commercial banks faced mean technical, allocative and cost efficiency scores of 0.964, 0.759 and 0.735 respectively during the study period. It implies that all conventional private banks could avoid wastage of 26.53 percent resources (cost inefficiency) to produce the present level output.

**Table 4.3: Efficiency of Conventional Private Commercial Banks (CPCBs)**

PCB	Efficiency	2017	2018	2019	2020	2021	2022	Mean
Pubali	TE	1.000	0.820	0.806	0.729	1.000	0.820	0.863
	AE	0.938	0.645	0.535	0.462	1.000	0.473	0.676
	CE	0.938	0.529	0.431	0.337	1.000	0.388	0.604
AB	TE	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	AE	1.000	0.914	0.912	0.825	1.000	1.000	0.942
	CE	1.000	0.914	0.912	0.825	1.000	1.000	0.942
NBL	TE	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	AE	0.984	0.889	1.000	0.955	0.465	1.000	0.882
	CE	0.984	0.889	1.000	0.955	0.465	1.000	0.882
City	TE	1.000	1.000	1.000	1.000	0.984	1.000	0.997
	AE	0.906	0.567	0.583	0.536	0.943	0.417	0.659
	CE	0.906	0.567	0.583	0.536	0.928	0.417	0.656
IFIC	TE	0.948	1.000	1.000	1.000	1.000	1.000	0.991
	AE	0.948	1.000	1.000	1.000	0.999	1.000	0.991
	CE	0.899	1.000	1.000	1.000	0.999	1.000	0.983
UCBL	TE	0.952	0.889	0.980	0.962	1.000	1.000	0.964
	AE	0.952	0.511	0.404	0.415	0.361	0.458	0.517
	CE	0.881	0.454	0.396	0.399	0.361	0.458	0.492
DBBL	TE	0.837	0.957	0.947	0.869	0.877	0.879	0.894
	AE	0.986	0.960	0.904	0.743	0.778	0.821	0.865
	CE	0.825	0.918	0.856	0.646	0.682	0.722	0.775
Prime	TE	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	AE	1.000	0.517	0.549	0.575	0.618	0.620	0.647
	CE	1.000	0.517	0.549	0.575	0.618	0.620	0.647
Southeast	TE	1.000	0.870	0.932	0.913	1.000	1.000	0.953
	AE	1.000	0.612	0.607	0.555	0.506	0.555	0.639
	CE	1.000	0.532	0.566	0.507	0.506	0.555	0.611
BRAC	TE	0.862	1.000	1.000	1.000	1.000	1.000	0.977
	AE	0.856	1.000	0.745	0.751	0.715	0.589	0.776
	CE	0.738	1.000	0.745	0.751	0.715	0.589	0.756
Mean	TE	0.960	0.954	0.967	0.947	0.986	0.970	0.964
	AE	0.957	0.762	0.724	0.682	0.739	0.693	0.759
	CE	0.917	0.732	0.704	0.653	0.727	0.675	0.735

Source: Author's Calculation based on DEA

#### 4.4 Relative Efficiency of Islamic Banks, State-owned and Conventional Private

The comparative analysis reveals that Islamic banks attained higher technical efficiency score (0.990), allocative efficiency score (0.797) and cost efficiency (0.789) compared to those of state-owned commercial banks and conventional private commercial banks (Table 4.4). All commercial banks faced mean technical, allocative and cost efficiency scores of 0.886, 0.698 and 0.641 respectively during the study period. It implies that all banks could avoid wastage of 35.95 percent resources (cost inefficiency) to produce the present level output.

**Table 4.4: Mean Efficiency of Islamic, NCBs and Private Commercial Banks**

Bank	Efficiency	2017	2018	2019	2020	2021	2022	Mean	Rank
Islamic Bank	TE	0.964	0.996	0.997	0.985	1.000	1.000	0.990	1
	AE	0.916	0.810	0.802	0.737	0.766	0.753	0.797	1
	CE	0.884	0.807	0.799	0.723	0.766	0.753	0.789	1
NCBS	TE	0.940	0.628	0.694	0.600	0.673	0.696	0.705	3
	AE	0.891	0.556	0.494	0.411	0.406	0.462	0.536	3
	CE	0.842	0.370	0.314	0.256	0.280	0.328	0.398	3
PCBs	TE	0.960	0.954	0.967	0.947	0.986	0.970	0.964	2
	AE	0.957	0.762	0.724	0.682	0.739	0.693	0.759	2
	CE	0.917	0.732	0.704	0.653	0.727	0.675	0.735	2
Overall Mean	TE	0.955	0.859	0.886	0.844	0.886	0.889	0.886	
	AE	0.921	0.709	0.673	0.610	0.637	0.636	0.698	
	CE	0.881	0.636	0.606	0.544	0.591	0.585	0.641	

Source: Author's Calculation based on DEA

#### 4.5 Efficiency of Commercial Banks Before, During and After Covid 19

The study also finds that the mean technical, allocative and cost efficiency scores of all banks fall during covid 19 period (2020) and rise after Covid 19 period. It implies that Bangladeshi commercial banks showed resilience after covid 19 period. Massive stimulus packages supported by Bangladesh Bank, the Central Bank and Government of Bangladesh have contributed greatly to attainment of resilience after covid 19 period. The Government declared stimulus packages amounting BDT 1,213.53 billion, i.e., 4.34 percent of the GDP up to November, 2020. Bangladesh Bank, being the monetary authority of the country quickly introduced voluminous refinance schemes, monetary easing and reviewing the key policy rates to ensure adequate liquidity and fund flows into the financial system to facilitate the faster recovery process of the real economy (Bangladesh Bank, 2021).

#### 5. Conclusion and Policy Directions

The present study examines and compares the technical, allocative and cost efficiency of commercial banks operating in Bangladesh during 2017-2022. It applies data envelopment analysis (DEA) to compute efficiency of 19 commercial banks which include five Islamic banks, four state-owned banks and ten conventional private commercial banks. Islamic banks outperform both conventional state-owned banks and conventional private commercial banks. The mean technical, allocative and cost efficiency scores were 0.990,

0.797, and 0.789 for Islamic commercial banks. The respective scores were 0.705, 0.536 and 0.398 for the state-owned banks and 0.964, 0.759 and 0.735 for conventional private commercial banks. The study finds that the mean technical, allocative and cost efficiency scores of all banks are 0.886, 0.698, and 0.641 respectively during 2017-2022. It implies that all banks could avoid wastage of 35.95 percent resources (cost inefficiency) to produce the present level output.

Based on the empirical results, the following policy directions can be deduced:

- i. In my study, the main source of cost inefficiency is allocative inefficiency and the minor source is technical inefficiency. Technical inefficiency occurs due to employing higher inputs to produce a certain level of output while allocative inefficiency is said to occur when the cost is not minimized with given output level and input price. It is clear that there is room to improve technical and allocative to promote cost efficiency scores of commercial banks by removing inefficiency.
- ii. The findings suggest commercial banks in Bangladesh for rationalizing financing and operating costs for removing allocative efficiency.
- iii. The commercial banks in Bangladesh, state-owned banks in particular can improve technical efficiency by promoting managerial performance. To this end, appointment of qualified persons in the Bank's Board and more allocation for salaries, training and skills development for bank staffs are required to remove managerial underperformance.
- iv. Bangladeshi commercial banks showed resilience after covid 19 period due to adoption of massive stimulus packages supported by Bangladesh Bank, the Central Bank and Government of Bangladesh. Adoption of stimulus packages will be required in future to address the adverse effects of crisis like Covid-19.
- v. The findings of the paper should be interpreted carefully. The adjustment of non-performing loan in output variable may reduce technical efficiency further. Our sample is based on 19 banks out of 58 commercial banks for 6 years period only. Moreover, performance evaluation of Islamic Banks needs to apply additional tools beyond traditional tools as these banks have to follow the rules of Islamic Shariah.
- vi. The DEA method has some weakness as it assumes that every input and output variables can be known without uncertainty. However, in practice, it is not possible to have data with homogeneous features. Measurement error and environmental factors affect form and position of the frontier. Given this, some scholars have continued efforts to further develop DEA for addressing the issues (Hossain et al., 2013).
- vii. To attain more reliable and robust findings, future research may include adoption of two methods rather than single method for methodological cross checking, selection of larger sample size with longer period and use of control and environmental variables in the model and inclusion of Maqasid al Shariah (objectives of Shariah) issues for efficiency analysis of Islamic commercial banks.

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## Appendix 1

## List of Islamic Banks, Branches and Windows, 2022

Bank Name Branches	Full-fledged Islamic Banks	Islamic Banking Branches of Conventional Banks	Islamic Banking Windows of Conventional Banks
1.	Islami Bank Bangladesh Limited (384)	The City Bank Limited (1)	Sonali Bank Limited (58)
2.	ICB Islamic Bank Limited (33)	AB Bank Limited (1)	Janata Bank Limited**
3.	Social Islami Bank Limited (179)	Dhaka Bank Limited (2)	Agrani Bank Limited (60)
4.	Al-Arafah Islami Bank Limited (208)	Premier Bank Limited (2)	Pubali Bank Limited (17)
5.	EXIM Bank Limited (147)	Prime Bank Limited (5)	Trust Bank Limited (15)
6.	Shahjalal Islami Bank Limited (140)	Southeast Bank Limited (6)	Bank Asia Limited (5)
7.	First Security Islami Bank Limited (209)	Jamuna Bank Limited (2)	Standard Chartered Bank (1)
8.	Union Bank Limited (112)	Bank Alfalah Limited (1)	Mercantile Bank Limited (46)
9.	Standard Bank Limited (138)	NRB Bank Limited (1)	Midland Bank Limited (1)
10.	Global Islami Bank Limited (99)	One Bank (2)	NRBC Bank Limited (268)
11.		UCB (1)	One Bank Limited (14)
12.			Meghna Bank Limited (9)
13.			Mutual Trust Bank Limited (15)
14.			Premier Bank Limited (25)

Sources: Bangladesh Bank (2022c).

Note: Figure in parenthesis indicate number of branches/windows

\*\*Janata Bank Limited has obtained permission for starting Islamic Banking window from Bangladesh Bank, but not yet started operation.

## Appendix II

### List of Sample Banks

#### **State Owned Commercial Banks (SCBs)**

1. Sonali Bank Limited (SB)
2. Janata Bank Limited (JB)
3. Agrani Bank Limited (AB)
4. Rupali Bank Limited (RB)

#### **Islamic Commercial Banks (ICBs)**

1. Islami Bank Bangladesh Limited (IBBL)
2. Al-Arafah Islami Bank Limited (AIBL)
3. Social Islami Bank Limited (SIBL)
4. Export Import (EXIM) Bank of Bangladesh Limited (EXIM)
5. Shahjalal Islami Bank Limited (SJIBL)

#### **Conventional Private Commercial Banks (CPCBs)**

1. Pubali Bank Limited (PUB)
2. AB Bank Limited (ABB)
3. National Bank Limited (NB)
4. The City Bank Limited (CB)
5. International Finance Investment and Commerce Bank Limited (IFIC)
6. United Commercial Bank Limited (UCB)
7. Dutch-Bangla Bank Limited (DBB)
8. Prime Bank Limited (PBL)
9. Southeast Bank Limited (SEB)
10. BRAC Bank Limited (BRAC)