Research Article

Technical Efficiency and Productivity of Private Commercial Banks in Bangladesh through DEA Approach

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Abstract: The present study examines the efficiency and productivity of 18 private commercial banks in Bangladesh by using a Malmquist Productivity Index (an extension of Data Envelopment Analysis) with a balanced panel data over the years 2013 to 2017. The empirical findings suggest that Bangladeshi private commercial banks have decreased their average annual productivity by 3.0% mainly owing to technical efficiency and technological change. However, technical efficiency decline is due to lack of management effectiveness rather than scale efficiency of the sample banks. The results of the study also indicate that only Eastern Bank Ltd. and Al-Arafah Islami Bank Ltd are found technically efficient during the study period, while remaining sample banks are categorized as inefficient. In the course of examining the productivity changes of the sample banks, this study found only 3 among the 19 banks used in this paper showed total progress in productivity, whereas sixteen banks displayed total decrease in productivity. The major policy implications are further discussed.

Keywords: Productivity, Technical efficiency, Technological change, Scale efficiency Change, Bangladesh

1. Introduction:

The foundation of sustainable economic development and long-term investments, the banking segment is considering one of the primary sources of funds (Schumpeter, 1934). In developing countries like Bangladesh, the productivity and efficiency of the banking sector make sure an effective financial system. According to Levine (1998), the effectiveness of the banking sector influences a nation's economic development; however, financial intermediation (bank)

insolvencies could effect in systematic and financial crisis because of negative impacts on the economy. In Bangladesh, the financial intermediation (bank) sector is one of the most significant elements of a nation's financial system (Fatema et al., 2019). Therefore, all financial institutions, including private commercial banks, are necessary to achieve economic aims put by the government of the country to ensure sustainable economic development.

The banks and financial sectors of Bangladesh are currently facing with maintaining healthy liquidity challenges due to the growing size of non-performing loans (NPLs)[1]. Therefore, they are not able to provide financing to potential business units and industries. Under the conditions, depositors, particularly public enterprises, become more worried about putting their money in the private commercial banks rather than they would much prefer to keep their money in the state-owned commercial banks. In light of these, the performance of Bangladeshi commercial banks remains to be an exciting topic of concern for many stakeholders comprising academicians, researchers, government, investors, business entities, and so on. Hence, most of the previous studies used ratios analysis for measuring banks' efficiency and productivity. To estimates, the efficiency and productivity of the banking and financial institutions, ratio analysis can be misleading and confusing (Rao and Tekeste, 2012). Besides, many researchers are also trying to use non-parametric Data Envelopment Analysis (DEA) and frontier analysis methods to identify the efficiency of banking sectors.

Therefore, the purpose of this study is to examine the efficiency and productivity of the commercial banks in Bangladesh over the years 2013–2017. To fulfill the objective of the study, we deploy the Slack-Based Data Envelopment Analysis (DEA) method.

2. Literature Review:

Nowadays, both academicians and researchers have shown significant interest in identifying the efficiency and productivity of banking sectors globally. To date, various studies have done based on the efficiency and productivity analysis in the banking sectors in developed countries and in developing countries like Bangladesh. Studies related to productivity and efficiency for banking sectors are reflected in the various studies (Samad, 2009; Sufian and Kamarudin, 2014; Islam and Kassim, 2015; Samad, 2019; Fatema et al., 2019; Nabi et al., 2019; Haque and Shoel, 2019; Rashid et al., 2020).

According to Fare, et al. (1994), the essential idea of efficiency is that it measures how well businesses change their input into profit in line with their measureable intentions. A firm is

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[1] See: https://www.thefinancialexpress.com.bd/views/liquidity-crisis-a-wake-up-call-for-the-banking-sector-1560785211; accessed on 23th March 2020.

said to be productive on the off chance that it can accomplish its objectives and unproductive in the event that it fails. In ordinary conditions, a company's objective is thought to be cost belittlement of production. According to the production theory, it is usually accepted that organizations are behaving proficiently in a monetary sense.

More recently, Rashid et al., (2020) used the malquist total factor productivity (TFP) method to examine productivity of the banking sectors in Bangladesh during the period 2013-2017 with a sample size of 30 by using DEA. The empirical findings of the study found that the annual average productivity of the banking sectors is 1.03%, and the productivity of the sample banks are notably weighted by ownership structure, board characteristics, and financial performance. In another study, Fatema et al., (2019 studied the efficiency and productivity analysis of the commercial banks in Bangladesh by using DEA and found that sample commercial banks are technically inefficient during the study period 2013-2017. Therefore, the study suggested that the most of the banks are technically inefficient due to the scale efficiency rather than pure technical efficiency.

By using DEA and SFA, Haque and Shoel, (2019) studied the efficiency of the banks in Bangladesh and discovered that the conventional and mixed commercial banks are more efficient than Islamic banks operated in Bangladesh. Hence, the study also identified that the Islamic banks are less efficient owing to their non-investment income. This study is support the result of Samad (2019), who empirically estimated the efficiency and it's determinants of the Islamic banks operated in Bangladesh during the study period between 2008 and 2012 through DEA. The output of the study found that the sample banks are technically inefficient ranged 1.6% and .5% respectively between 2008 and 2012.

Hassan and Hassan, (2018) investigated the cost efficiency of the banking industry of Bangladesh by employing the single stage stochastic frontier analysis (SFA), and the study observed that the average cost-efficiency of the Bangladeshi banking division is nearly about 90.00%. The study also found that the average cost-efficiency of the conventional commercial banks and Islamic banks are better than stated –owned commercial banks. Therefore, the banking industry sector is experiencing a low technological improvement during the study period between 2011 and 2015 due to the non-performing loans.

However, various recent studies have tried to find out the productivity and efficiency of commercial banks in Bangladesh and have found similar results that the overall banking sectors in Bangladesh are lack of technical efficiency, pure technical efficiency, and scale efficiency. Therefore, the main aim of this study is to identify the efficiency and productivity of the commercial banks in Bangladesh.

3. Methodology of the Study:

3.1 Method of Data Analysis

This study employed secondary data that were collected from the annual reports of listed private commercial banks in the Dhaka Stock Exchange (DSE) of Bangladesh for the period under investigation from 2013 to 2017. To determine banks' efficiencies, Banker, Charnes, and Cooper (BCC) and Charnes, Cooper, and Rhodes (CCR) input-oriented DEA models are used. Further, the study uses the DEA-based output-orientated MPI to evaluate both technical efficiency and productivity growth of the bank. According to (Sharma et al. 2013), two methods are existing in assessing productivity—the Stochastic Frontier Approach (SFA) and DEA, but DEA has gotten the most significant lately. In this study, we include 18 private commercials banks (see Table AI), of which information is available from 2013 to 2017.

3.2 Data Envelopment Analysis (DEA) Method

According to (Berger and Humphrey, 1997) Data envelopment analysis is the non-parametric technique that is applied to develop a set of preeminent exercises or frontier explanations. Charnes et al. (1978) characterized productivity as a weighted entirety of yields to a weighted aggregate of data sources. The present study used CCR and BCC models to examine the relative efficiency and Malmquist productivity index (MPI) to measure TFP change. Here is the formula for calculating the effectiveness of the selected banks is given below:

$$\text{Efficiency} = \frac{\text{The weighted sum of outputs}}{\text{The weighted sum of inputs}}$$

3.3 Malmquist TFP index

The Malmquist Productivity Index was firstly employed by (Malmquist, 1953), in examining the productivity of the financial and non-financial commercial banking institutions. It can be either input-oriented or output-oriented, and this technique has three advantageous primary conditions of MPI. For that reason, it works better compared to other methods. First, it doesn't need the cost minimization or profit augmentation assumption. Second, there is no expectation of data and revenue prices. Third, if there is panel data, the approach allows the worsening of profitability into two. The Malmquist productivity index applied to calculate the productivity changes of the banks over the specified period and rotten it to TE change and technological changes, according to the following calculation. For more details, see (Fare et al., 1994)

$$M_0\left(y_{t+1}, x_{t+1}, y_t, x_t\right) = \left[\frac{d_0^t\left(x_{t+1}, y_{t+1}\right)}{d_0^t\left(x_t, y_t\right)} \times \frac{d_0^{t+1}\left(x_{t+1}, y_{t+1}\right)}{d_0^{t+1}\left(x_t, y_t\right)}\right]^{\frac{1}{2}} \quad \ldots\ldots\ldots\ldots (3.2)$$

$$M_0 = \left[\frac{d_0^t\,(x_{t+1},y_{t+1})}{d_0^{t+1}(x_t,\,y_t)}\right] \times \left[\frac{d_0^t(x_{t+1},y_{t+1})}{d_0^{t+1}(x_{t+1},\,y_{t+1})} \times \frac{d_0^t\,(x_t,y_t)}{d_0^{t+1}(x_t,\,y_t)}\right]^{\frac{1}{2}} \quad \text{…………………}(3.3)$$

It means the productivity of the generation point ($xt+1$, $yt+1$) comparative to the foundation point (xt, yt). Value more prominent than 1 signifies positive TFP extension from period t to t+1.

$$M_0 = TEC\,(y_{t+1},\,x_{t+1}\,y_t\,x_t) \times TC\,(y_{t+1},\,x_{t+1}\,y_t\,x_t). \quad \text{………………………………}(3.4)$$

The TEC can be additional broken down into unadulterated specialized effectiveness change (PTE) and scale productivity (SE). Following Färe et al. (1994), the disintegration of TEC in Eq. (3) is according to the associated,

$$TEC = \frac{D_{VRS}^{t+1}\,(x_{t+1},y_{t+1})}{D_{VRS}^t\,(x_t,\,y_t)} \times \frac{D_{CRS}^{t+1}\,(x_{t+1},y_{t+1})/\,D_{VRS}^{t+1}\,(x_{t+1},y_{t+1})}{D_{CRS}^t\,(x_t,\,y_t)/\,D_{VRS}^t\,(x_t,\,y_t)} \quad \text{…………………}(3.5)$$

Where DVRS is the separate yield limit with regards to variable return to scale (VRS) and DCRS is the different yield limit with regards to predictable return to-scale (CRS). The hidden segment of Eq. (3.5) addresses the PTE while the second part tends to SE. The PTE shows the utmost of DMU to keep up a fundamental division from wastage by utilizing responsibilities to pass on the best yield while SE is the capacity to work at an ideal scale (Bassem, 2014). The multiplication of TC and TEC produces TFP whose value more than 1 is productivity improvement, less than one regresses, and one is stagnant.

3.4 Selection of Variables and Approaches for the Study

The intermediation, the production, and profit approaches were extensively employed to define the inputs and output variables in the study of the banks efficiency globally (Sealey and Lindley, 1977; Frexias and Rochet, 1997). The intermediation approach describes a bank act as an intermediary that alters assets from the surplus parts to deficiency parts. Therefore, the intermediation approach is the most used method to examine the efficiency of the banking industries among the investigators deploying the Data Envelopment Analysis (DEA) technique (Fatema, et al. 2019; Sufian, et al. 2012; Bader, et al. 2008; Sufian, et al. 2012).

The production approach demonstrates that financial organizations like banks act as makers of services for account holders, and therefore the inputs are the physical elements such as labour and capital and all other assets as well as liabilities are outputs. Various previous studies have been deployed the production approach (DeYoung 1997; Ferrier and Lovell, 1990; Fried, et al. 1993). While the profit approach is based on (Berger and Mester, 1997) who indicated that

"use of the profit approach may help take into account unmeasured changes in the quality of banking services by including higher revenues paid for the improved quality, and may help capture the profit maximization goal by including both the costs and revenues"

Hence, the present study used two input variables and one output variables by applying an intermediation method to identify the efficiency and productivity of the selected commercial banks in Bangladesh. The choice of the inputs and outputs factors based on the study Muvingi and Hoteral (2015). For more details, see (Muvingi and Hoteral 2015; Fatema, et al.2019) The bank's deposits and operating expenses were considered as inputs, while loans and advances were regarded as outputs.

4. Data Analysis and Findings:

The present study was used to determine efficiency scores and productivity indices by using DEA 2.1 statistical software.

Table I shows the descriptive statistics of the input and output variables used in the study. Here, the average operating expenses among the sample banks is BDT 10,338.16 million, with the standard deviation of BDT 6,082.82 million and ranges from BDT 2,667.14 million to BDT 86, 568.00 million. This empirical findings indicates that there are substantial variances exist among the sample banks in operating expenses, total deposits, and total loan and advances.

Table I. Descriptive Statistics of the input and output variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Operating Expenses(x1)	90	10338.16	6082.82	2667.14	86568.00
Total Deposits (x2)	90	194123.6	116150.12	23417.87	755022.3
Total Loan and Advances (y1)	90	175123.7	120105.36	64829.8	748672.5

* Amount in BDT million Taka
Source: Author's computation based on annual reports of sample Banks

Table II demonstrates the outcome of the technical efficiency of private commercial banks operating in Bangladesh. These TE scores have taken by using output-based CRS (Constant Returns to Scale) data envelopment analysis. It observed that from the table, most of the selected private commercial banks were discovered technically inefficient during the study period between 2012 and 2017 except two banks, namely Al-Arafah Islami Bank Ltd. and Eastern Bank Ltd.

Table II. Technical Efficiency of Sample Banks

SL	Bank Name	Technical Efficiency
1	AB Bank Ltd.	0.973

2	Al-Arafah Islami Bank Ltd.		1.000
3	Bank Asia Ltd.		0.867
4	BRAC Bank Ltd.		0.853
5	Dutch-Bangla Bank Ltd.		0.806
6	Dhaka Bank Ltd.		0.909
7	Eastern Bank Ltd.		1.000
8	Export-Import Bank of Bangladesh Ltd.		0.818
9	Islami Bank Bangladesh Ltd.		0.992
10	Mercantile Bank Ltd.		0.915
11	National Bank Ltd.		0.828
12	One Bank Ltd.		0.937
13	Shahjalal Islami Bank Ltd.		0.992
14	Southeast Bank Ltd.		0.790
15	Standard Bank Ltd.		0.865
16	City Bank Ltd.		0.974
17	United Commercial Bank Ltd.		0.853
18	Uttara Bank Ltd.		0.645
	Mean		**0.890**

Table III. Improvements in Inputs and Outputs of Sample Banks during 2017

Bank Name	Variables	Original value	Radical Movement	Slack Movement	Projected Value
AB Bank Ltd.	Total Loan and Advances	229647.000	6422.626	0.000	236069.626
	Total Deposits	5871.000	0.000	0.000	5871.000
	Operating Expenses	235954.000	0.000	0.000	235954.000
Al-Arafah Islami Bank Ltd.	Total Loan and Advances	235905.000	0.000	0.000	235905.000
	Total Deposits	5308.000	0.000	0.000	5308.000
	Operating Expenses	244806.000	0.000	0.000	244806.000
Bank Asia Ltd.	Total Loan and Advances	197504.000	30172.065	0.000	227676.065
	Total Deposits	16121.000	0.000	-9186.559	6934.441
	Operating Expenses	207041.000	0.000	0.000	207041.000
BRAC Bank Ltd.	Total Loan and Advances	203431.000	35119.668	0.000	238550.668
	Total Deposits	9660.000	0.000	-2394.346	7265.654
	Operating Expenses	216930.000	0.000	0.000	216930.000
Dutch-Bangla Bank Ltd.	Total Loan and Advances	207257.000	49840.644	0.000	257097.644
	Total Deposits	17867.000	0.000	-10036.452	7830.548
	Operating Expenses	233796.000	0.000	0.000	233796.000
Dhaka Bank Ltd.	Total Loan and Advances	154017.000	15412.527	0.000	169429.527
	Total Deposits	4171.000	0.000	0.000	4171.000
	Operating Expenses	170035.000	0.000	0.000	170035.000
Eastern Bank Ltd.	Total Loan and Advances	184027.000	0.000	0.000	184027.000
	Total Deposits	5605.000	0.000	0.000	5605.000
	Operating Expenses	167348.000	0.000	0.000	167348.000
Export-Import Bank of Bangladesh Ltd.	Total Loan and Advances	255033.000	56880.823	0.000	311913.823
	Total Deposits	20893.000	0.000	-11392.889	9500.111
	Operating Expenses	283644.000	0.000	0.000	283644.000
Islami Bank Bangladesh Ltd.	Total Loan and Advances	748673.000	6310.890	0.000	754983.890
	Total Deposits	18751.000	0.000	0.000	18751.000
	Operating Expenses	755022.000	0.000	0.000	755022.000
Mercantile Bank Ltd.	Total Loan and Advances	199661.000	18627.241	0.000	218288.241
	Total Deposits	5284.000	0.000	0.000	5284.000
	Operating Expenses	220517.000	0.000	0.000	220517.000
National Bank Ltd.	Total Loan and Advances	248467.000	51490.148	0.000	299957.148
	Total Deposits	21887.000	0.000	-12751.059	9135.941
	Operating Expenses	272771.000	0.000	0.000	272771.000
One Bank Ltd.	Total Loan and Advances	170393.000	11515.627	0.000	181908.627
	Total Deposits	4471.000	0.000	0.000	4471.000
	Operating Expenses	182675.000	0.000	0.000	182675.000

Shahjalal Islami Bank Ltd.	Total Loan and Advances	158668.000	0.000	1203.724	159871.724
	Total Deposits	11961.000	0.000	-7091.709	4869.291
	Operating Expenses	145382.000	0.000	0.000	145382.000
Southeast Bank Ltd.	Total Loan and Advances	234317.000	62403.829	0.000	296720.829
	Total Deposits	18244.000	0.000	-9206.629	9037.371
	Operating Expenses	269828.000	0.000	0.000	269828.000
Standard Bank Ltd.	Total Loan and Advances	128228.000	19931.176	0.000	148159.176
	Total Deposits	10776.000	0.000	-6263.444	4512.556
	Operating Expenses	134731.000	0.000	0.000	134731.000
City Bank Ltd.	Total Loan and Advances	196596.000	5185.117	0.000	201781.117
	Total Deposits	8047.000	0.000	-1901.254	6145.746
	Operating Expenses	183493.000	0.000	0.000	183493.000
United Commercial Bank Ltd.	Total Loan and Advances	261003.000	44918.740	0.000	305921.740
	Total Deposits	9431.000	0.000	-113.393	9317.607
	Operating Expenses	278195.000	0.000	0.000	278195.000
Uttara Bank Ltd.	Total Loan and Advances	105261.000	58055.980	0.000	163316.980
	Total Deposits	12086.000	0.000	-7111.775	4974.225
	Operating Expenses	148515.000	0.000	0.000	148515.000

Amount in BDT million Taka
Source: Author's computation based on annual reports of sample Banks

According to Table III above, only Al-Arafa Islami Bank Limited and Eastern Bank Limited were found fully efficient in 2017; hence the original values were the same as projected values for both banks. On the other side, remaining sample banks are required to improvements in their inputs (total deposits & operating expenses) to achieve the efficiency frontier. For instance, in the case of Uttara Bank Limited, the bank required to increase its loan and advances by TK 58055.980 (in a million), and the bank should have been targeted Tk 4974.225(in a million) in deposits to be technically more efficient.

Table IV. Benchmark (lambda) for the sample banks

SL	DMU	Efficiency Score	Benchmark (Lambda)
1	AB Bank Ltd.	0.973	EBL (0.382);AIBL(0.703)
2	Al-Arafah Islami Bank Ltd.	1.000	AIBL (1.00)
3	Bank Asia Ltd.	0.867	EBL(1.237)
4	BRAC Bank Ltd.	0.853	EBL(1.296)
5	Dutch-Bangla Bank Ltd.	0.806	EBL(1.397)
6	Dhaka Bank Ltd.	0.909	EBL (0.245);AIBL(0.527)
7	Eastern Bank Ltd.	1.000	EBL(1.00)
8	Export-Import Bank of Bangladesh Ltd.	0.818	EBL(1.695)
9	Islami Bank Bangladesh Ltd.	0.992	EBL (1.204);AIBL(2.261)
10	Mercantile Bank Ltd.	0.915	EBL (0.254);AIBL(0.727)
11	National Bank Ltd.	0.828	EBL(1.630)
12	One Bank Ltd.	0.937	EBL (0.258);AIBL(0.570)
13	Shahjalal Islami Bank Ltd.	0.992	EBL(0.869)
14	Southeast Bank Ltd.	0.790	EBL(1.612)
15	Standard Bank Ltd.	0.865	EBL(0.805)
16	City Bank Ltd.	0.974	EBL(1.096)
17	United Commercial Bank Ltd.	0.853	EBL(1.662)
18	Uttara Bank Ltd.	0.645	EBL(.887)

Source: Author's computation

Table IV presents the standard (lambda) for the sample banks and their activities. From the above table, we can see that most of the banks were found inefficient within the range of 0.645 to 0.992 (inefficiency less than 1); however, only two sample banks (AIBL & EBL) were found technically efficient during the study period. Although Table IV is not given any definite results, we can observe that most of the sample banks are unproductive, excluding EBL & AIBL, and their associated benchmarks for all sample banks also shown in the tables. Therefore, Eastern Bank has selected as the benchmark for a maximum of sixteen times for other sample banks. In contrast, Al-Arafah Islami Bank has even opted for five times as the standard.

Table V. Malmquist TFP Index Summary of Sample Banks Average

SL	Bank Name	EFFCH	TECHCH	PECH	SECH	TFPCH
1	AB Bank Ltd.	0.971	1.000	0.984	0.987	0.971
2	Al-Arafah Islami Bank Ltd.	1.000	1.012	1.000	1.000	1.012
3	Bank Asia Ltd.	0.975	0.977	0.983	0.992	0.953
4	BRAC Bank Ltd.	1.025	0.977	1.033	0.992	1.002
5	Dutch-Bangla Bank Ltd.	0.976	0.977	0.979	0.997	0.954
6	Dhaka Bank Ltd.	0.986	1.005	1.000	0.986	0.991
7	Eastern Bank Ltd.	0.968	0.975	0.988	0.979	0.944
8	Export-Import Bank of Bangladesh Ltd.	1.017	0.977	1.014	1.003	0.994
9	Islami Bank Bangladesh Ltd.	1.002	0.997	1.000	1.002	1.000
10	Mercantile Bank Ltd.	0.962	0.988	0.986	0.975	0.951
11	National Bank Ltd.	0.985	0.977	0.980	1.005	0.962
12	One Bank Ltd.	0.985	0.998	1.000	0.985	0.983
13	Shahjalal Islami Bank Ltd.	0.972	0.977	0.996	0.976	0.950
14	Southeast Bank Ltd.	0.990	0.977	0.987	1.003	0.967
15	Standard Bank Ltd.	0.993	0.977	0.987	1.006	0.970
16	City Bank Ltd.	0.962	0.977	0.980	0.981	0.940
17	United Commercial Bank Ltd.	0.985	0.978	0.982	1.003	0.963
18	Uttara Bank Ltd.	0.975	0.977	0.992	0.982	0.952
	Mean	*0.985*	*0.985*	*0.993*	*0.992*	*0.970*

Source: Author's computation

Table V confirms that the average Total Factor Productivity (TFP) decrease for Bangladeshi commercial banks from 2013 to 2017 is 3.00%. The overall reduction of TFP consists of an efficiency and technological efficiency decline of 1.5%; whereas, a pure efficiency reduction by 0.7% and a scaling efficiency decrease by 0.8%. Therefore, it can be said that the decline in TFP is due to the technical efficiency depreciate rather than pure technical efficiency and scale efficiency in listed commercial banks.

Moreover, Figure 1 shows the total factor productivity changes of sample banks. The empirical findings indicate that the AIBL is the utmost average definite increase in TFP of 1.2%. The 1.2% total factor productivity increase for AIBL is composed of a technological efficiency increase of 1.2%. In contrast, the city bank witnessed the lowest average TFP change, with a

decrease of 6.00% in total factor productivity. Therefore, the empirical finding also demonstrates that fifteen out of eighteen banks employed in the current study exhibited an absolute reduction in productivity. The rest of the three banks, namely, Al-Arafah Islami Bank Ltd., Brack Bank Ltd, and Islami Bank Bangladesh Ltd., found an overall increase in total factor productivity.
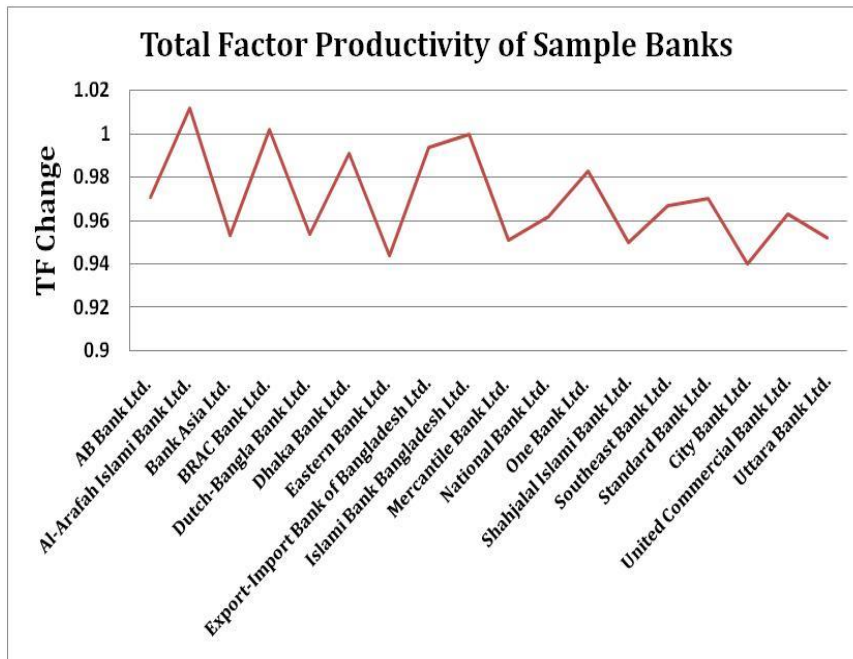

Figure 1. Bank's Total Factor Productivity Changes

Table VI displays the average change in total factor productivity and its elements by year from 2014 to 2017. The empirical findings suggest that the average TFP change during (2014-2017) is 0.970, which implies an overall decline in total factor productivity of sample banks operated in Bangladesh. That happens due to the average annual technical efficiency (TE) and the technological change (TC) by 0.985. Therefore, it is clear that the overall factor productivity of private commercial banks is decreasing due to the TE and TC. Thus, the empirical results also discover that the average annual SE change is about 0.992, while PTE change is accountable for 0.993. It can also be identified that TE decrease is owing to lack of management effectiveness rather than scale efficiency of the sample banks.

Table VI. Average Changes in TFP and Its Elements by Year

Year	EFFCH	TECHCH	PECH	SECH	TFPCH
2014	0.953	0.995	0.967	0.986	0.948
2015	1.015	0.965	1.017	0.998	0.979
2016	0.992	0.989	0.988	1.003	0.981
2017	0.980	0.990	1.000	0.980	0.971
Average	*0.985*	*0.985*	*0.993*	*0.992*	*0.970*
Source: Author's computation					

5. Conclusions, study limitations and future research

This study investigates the efficiency and productivity of the commercial banks in Bangladesh over the years 2013 to 2017. The DEA and MPI approach was employed with a balanced dataset of 90 observations from eighteen commercial banks operating in Bangladesh to identify the efficiency and productivity. The empirical findings indicate that the most of the selected private commercial banks were discovered technically inefficient during the study period between 2013 and 2017 with the exception of two banks, namely AIBL and EBL. The results of the study also endorses that the average TFP decrease for Bangladeshi commercial banks is 3.00%. The overall reduction of TFP consists of an efficiency and technological efficiency decline of 1.5%; whereas, a pure efficiency reduction by 0.7% and a scaling efficiency decrease by 0.8%. So, it can be said that the decline in TFP is due to the technical efficiency depreciate rather than pure technical efficiency and scale efficiency in listed private commercial banks in Bangladesh. Furthermore, the empirical outputs also demonstrate that the fifteen out of eighteen banks employed in the present study showed an absolute reduction in productivity, while, the rest of the three banks, namely, AIBL, BBL, and IBBL were found an overall increase in total factor productivity.

The empirical findings also offer some useful implications for managers, decision-makers, and regulators to measure the efficiency and productivity growth in Bangladeshi banking sectors. The managers of the inefficient banks should take care about scale and technical efficiency while allocating their inputs. Therefore, the administrators of inefficient banks have to utilize their inputs (total deposits & operating expenses) properly to achieve the efficiency frontier. Moreover, the sample banks' administrators need to organize training and development program to increase managerial skills to improve the productivity. Finally, the banking institutions are playing a crucial role for the development of the country's economy, so, Bangladesh bank (the central bank of Bangladesh) should strongly monitor and provide guidance the other banks to maintain their efficiency and productivity levels.

Even with the aforementioned empirical results of the study, however, we admit that the present research work has particular limitations. First, the study was restricted to only 18 private commercial banks in Bangladesh among the total number of 47 banks[2]. Second, the study has only taken two input variables and one output variable for the study rather than other important variables of the banks. Lastly, the generalization of our results is restricted to the private commercial banks only. Therefore, readers recommended to interpret and exercise findings of

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[2] For more details, see https://www.newspapersstore.com/bangladesh-banks-list/

the study with caution, while simplifying the outputs away from this circumstance. Therefore, the future study may look at the extra variables to identify the efficiency and productivity levels of the whole banking sectors in Bangladesh.

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Appendix

<p style="text-align:center">**Table AI:** Sample of the Study</p>

Bank	Abbr.
AB Bank Ltd.	ABBL
Al-Arafah Islami Bank Ltd.	AIBL
Bank Asia Ltd.	BAL
BRAC Bank Ltd.	BBL
Dutch-Bangla Bank Ltd.	DBBL
Dhaka Bank Ltd.	DBL
Eastern Bank Ltd.	EBL
Export-Import Bank of Bangladesh Ltd.	EXIMBL
Islami Bank Bangladesh Ltd.	IBBL
Mercantile Bank Ltd.	MBL
National Bank Ltd.	NBL
One Bank Ltd.	OBL
Shahjalal Islami Bank Ltd.	SJIBL
Southeast Bank Ltd.	SEBL
Standard Bank Ltd.	SBL
City Bank Ltd.	CBL
United Commercial Bank Ltd.	UCBL
Uttara Bank Ltd.	UBL

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Conflicts of Interest

There are no conflicts to declare.

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