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ARE ISLAMIC BANKS LESS EFFICIENT THAN OTHER BANKS? EVIDENCE FROM BANGLADESH

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ABSTRACT

Considering the recent shrinkage in Islamic banks' profitability in Bangladesh, this study investigated whether these banks are less efficient than the conventional and mixed banks. Using 250 firm-year observations from 38 private commercial banks for the years from 2011 to 2017 and estimating operational efficiency through the Data Envelopment and Stochastic Frontier Analyses, we found robust evidence that Islamic banks are less efficient than the conventional and mixed banks. In additional analysis, it was found that the lower efficiency of Islamic banks was driven by their non-investment income. A significant negative shift in Islamic banks' efficiency was evident in the most recent years compared to the earliest periods in our sample window. These findings helped us explain why the relative profitability of Islamic banks has declined recently. We suggest that Islamic banks' management pay more attention to their portfolio of non-investment products and services in order to remain competitive in the fast-growing banking landscape in Bangladesh.

Contribution/ Originality: This study contributes to the existing literature on estimating banks' efficiency through the techniques of frontier analysis. While revenue is one of the primary sources of cash inflows, research examining banks' efficiency in generating revenues by utilizing their resources is scarce. We filled this gap in the literature.

1. INTRODUCTION

The recent statistics show a contraction in Islamic banks' profitability relative to the conventional banks in Bangladesh. For instance, Islamic banks' profitability in 2016 was 3.6% compared to 1.9% for the conventional banks[1]. However, their profitability has started to decline since then. In 2017, the net profit margin of Islamic banks decreased to 3% and then to 2.2% in 2018; whereas the banking sector's overall profitability in 2018 improved to 3% from 2% in 2017[2].

Given the role that the banking sector plays in a developing economy like Bangladesh, these stats are concerning and require further attention. However, existing research has been silent on what causes such a negative

[1] See https://www.thedailystar.net/business/banking/islamic-banking-growing-rapidly-1417531; accessed on 4 Sep 2019.

[2] See https://www.thedailystar.net/business/banking/news/islamic-banks-profitability-shrinks-2018-1744336; accessed on 4 Sep 2019.

shift in Islamic banks' profitability. This study examined whether this decline in Islamic banks' profitability was due to their relative inefficiencies in utilizing resources. We explored if Islamic banks were less efficient in recent years compared to the conventional and mixed (i.e., rendering both conventional and Islamic banking services) banks.

In doing so, we used two commonly used frontier analysis techniques: the Data Envelopment Analysis (DEA hereinafter) and the Stochastic Frontier Analysis (SFA hereinafter). We executed our tests using 250 firm-year observations from 38 private commercial banks in Bangladesh for the years from 2011 to 2017.

The DEA results indicated that Islamic banks' efficiency was significantly lower than that of the conventional and mixed banks. We found qualitatively similar results under the SFA approach as well. In additional analyses, we decomposed our output variable (i.e., total operating revenue) into investment and non-investment income and found that Islamic banks' relative inefficiency was driven by their non-investment income. We also found that Islamic banks' average efficiency in the last three years of our sample period was relatively lower than the average efficiency of conventional banks for the similar periods. There was no difference in average efficiency between the Islamic and conventional banks in the earliest years of our sample window.

This study contributes to the extant literature in several ways. First, while most of the earlier studies used banks' intermediate outputs such as loans, investments, and other earnings assets in estimating efficiency (e.g., (Sufian and Kamarudin, 2014; Islam and Kassim, 2015; Fatema *et al*., 2019; Nabi *et al*., 2019)) little was known about banks' efficiency in terms of generating revenues by deploying their resources. We filled this gap in the literature by using the total operating revenue as the output variable. We preferred this approach because revenue is the ultimate goal of these intermediate outputs, as well as the primary source of earnings and cash flows (Baik *et al*., 2013; Afaq *et al*., 2019).

Second, this paper contributes to the ongoing debate on relative superiority of different clusters of banks in Bangladesh. In a study closely related to ours, Nabi *et al*. (2019) found that Islamic banks are technically more efficient than the conventional banks. However, using a different output variable (i.e., revenue) we found the opposite. These conflicting findings highlight the importance of looking at the output measure in interpreting relative efficiency estimations.

Third, while prior studies use the DEA or SFA approach in isolation (e.g., (Ali, 2015; Islam and Kassim, 2015; Fatema *et al*., 2019; Nabi *et al*., 2019; Samad, 2019)) we used both of these approaches in our analyses. Given the limitations the DEA approach has (see Baik *et al*. (2013)) confirming its results using alternative approaches is imperative. Hence, our findings are more robust compared to those in previous studies.

Finally, this study should be of interest especially to the Islamic banks' management. We suggest that they focus on improving their level of efficiency. Otherwise, Islamic banks might be facing challenges in near future, for instance in collecting deposits. In this respect, they may look into their portfolio of products and services, and redesign them.

The remainder of this paper is structured as follows. Section two presents relevant prior studies. Section three describes our data and variables. Section four shows the results and discussion. Section five presents the summary and conclusion.

2. RELATED LITERATURE

The efficient use of resources is imperative for every organization, be it for profit or not-for-profit. It not only helps in achieving higher rate of return but also contributes to the economic growth and development. Inefficient use of resources, on the other hand, hinders economic progress. Therefore, the government and policy makers are always interested in knowing if economic sectors are using the available resources effectively and efficiently.

Banking is an economic sector that is one of the most important indicators of macroeconomic stability and progress of any country. Hence, the policy makers have incentives to investigate the efficiency of the banking industry. Banks also have their own motivations to ensure efficiency because they are predominantly funded by

deposits, and the collection of which is largely contingent on the proper use of such resources (Bhatia *et al.*, 2018). Several studies have given attention to measuring banks' operating efficiency by using non-parametric (e.g., DEA) as well as parametric (e.g., SFA) approaches[3].

The DEA is a non-parametric approach that measures operational efficiency by identifying the best practice frontier and then by evaluating the performance of decision-making units (DMUs) against that best practice. This approach has two advantages. One, it does not assume a particular functional form of the relation between inputs and outputs in an arbitrary manner; and two, because optimal weights in DEA are derived from the data, it avoids the need to assign a priori factor weights (Cooper et al., as cited in (Baik *et al.*, 2013; Cheng *et al.*, 2018)). However, there are criticisms on using the DEA approach in measuring efficiency. For instance, it derives efficiencies without judging the value of different outputs and inputs (Baik *et al.*, 2013).

The SFA is a parametric approach which assumes that the deviation of a DMU from the best practice frontier results from two sources: symmetric random noise, and inefficiency component. Therefore, this approach differs from the DEA which does not allow DMUs to deviate from the best practice due to random shocks (Baik *et al.*, 2013). To date, the DEA and SFA approaches have been used by numerous studies in measuring bank's efficiency across a wide range of settings[4]. One subset of this literature focuses on the efficiency of banks in Bangladesh either of the conventional or Islamic banks in isolation, or both.

Using the DEA, Sufian and Kamarudin (2014) studied the level of profit efficiency of banks in Bangladesh and found that this sector exhibited a decrease in efficiency in 2009 relative to 2004. Hence, the study suggested that the banks in Bangladesh need to improve their efficiency in order to maximize profit and shareholders' wealth. Several later studies found the same scenario. For instance, the profit efficiency of both the state-owned and the private commercial banks continued to show a decreasing trend for the post financial crisis years (e.g., Kamarudin *et al.* (2016)) although financial reform policies contributed in reducing banks' costs (Robin *et al.*, 2018).

Going one step forward, a number of studies compared the efficiency of the Islamic and conventional banks in Bangladesh, but they failed to reach in a consensus on whether the former are more efficient than the latter (or vice-versa). For instance, Nabi *et al.* (2019) found that the Islamic commercial banks outperform the conventional banks in technical and pure technical efficiencies though fall short in scale efficiency. Similarly, Islam and Kassim (2015) found that the Islamic banks trump over conventional banks in pure technical efficiency but they are less efficient in technical and scale efficiencies. Islamic banks have also been found as less efficient and less financially stable in other studies (e.g., (Hassan, 2006; Islam *et al.*, 2019)).

In contrast, in a study on banks from 21 countries including Bangladesh, Bader *et al.* (2008) found no significant difference in overall efficiency between the Islamic and conventional banks. However, Islamic banks have been found to completely outperform the conventional banks in other studies (e.g., (Asmild *et al.*, 2018; Mamun *et al.*, 2018; Rasel *et al.*, 2018)).

Although the above studies made valuable contributions to the literature and advanced our understanding on the banking sector's efficiency in Bangladesh, their findings can be criticized from two points: their approaches in selecting the output variable(s), and their predominant use of the DEA approach. In selecting the output variable, they followed the intermediation approach, and accordingly, used loans, investments, and other earnings assets, among others, as the outputs in DEA. This approach, however, ignores the ultimate goal of private commercial banks which is earning revenue (Havidz and Setiawan, 2015).

With the exception of Hassan (2006) and Robin *et al.* (2018), there are hardly any prior studies which used the SFA approach in measuring banks' efficiency in Bangladesh. While Hassan (2006) study was limited to Islamic

[3] Other than using parametric and non-parametric methods, prior studies use ratios in examining banks operational efficiency. For instance, see Ouerghi (2014) and Bhatia, Basu, Mitra and Dash (2018).

[4] See Bhatia, Basu, Mitra and Dash (2018) for a recent review.

banks only, Robin *et al.* (2018) covered twelve commercial banks for the years from 1983 to 2012. However, they did not compare the efficiency of different bank groups, such as the Islamic and conventional banks.

Overall, there are a lack of studies in the context of Bangladesh that examine different bank groups' relative efficiency by employing both the parametric and non-parametric approaches, and that address their recent state of affairs. Such a study is important given the recent ups and downs in Islamic banks' profitability, and a change in their paradigm from participatory to asset based financing (Suzuki and Uddin, 2016; Islam and Sultana, 2019).

3. DATA SOURCES, VARIABLES, AND SAMPLE DESCRIPTION

3.1. The Sample

The data needed for our analyses have been collected from the audited financial statements of the private commercial banks in Bangladesh for the years from 2011 to 2017. We closed our sample window in 2017 because it was the latest year till which all of our required data were publicly available. As of December 2017, there were 57 scheduled banks (eight state-owned, 40 private commercial, and nine foreign banks) in Bangladesh.

We excluded the state-owned banks because they were fully owned and managed by the government and somewhat different from private commercial banks in terms of rendering services. Foreign commercial banks were also excluded as their operations, size and ownership characteristics were different from domestic commercial banks. Out of the 40 private commercial banks, the Farmers Bank (currently Padma Bank) and Shimanto Bank were excluded due to the required data not being available.

These restrictions resulted in a final sample of 250 firm-year observations from 38 private commercial banks[5]. We classified these 38 banks into three categories: Islamic (eight), conventional (nineteen), and mixed (eleven) (i.e., banks offering both the conventional and Islamic products and services).

3.2. Input and Output Variables, and Estimation of Efficiency

In measuring the operating efficiency, we used three inputs and one output variable. As inputs, we used total deposits, number of employees, and total fixed assets. As output, we used the total operating revenue. In contrast to the previous studies on estimating banking sector's efficiency in Bangladesh, we used total operating revenue as the output measure because it is the ultimate objective of the private commercial banks. Therefore, our efficiency analysis was different from the prior studies, especially in the context of Bangladesh (e.g., (Hassan, 2006; Sufian and Kamarudin, 2014; Islam and Kassim, 2015; Fatema *et al.*, 2019; Nabi *et al.*, 2019)).

Using these input and output variables, we measured three efficiencies under the DEA approach: technical (TE hereinafter), pure technical (PTE hereinafter), and scale efficiency (SE hereinafter). We estimated the output-oriented efficiency for each year separately. We used the same inputs and output variables to determine the efficiency under the SFA approach. Note that we included year dummies in the SFA estimation to control for time effects, and used a truncated normal distribution assumption for the inefficiency term (For a more detailed discussion of the estimation process, see (Baik *et al.*, 2013; Ali, 2015; Kamarudin *et al.*, 2016; Nabi *et al.*, 2019; Samad, 2019).

3.3. Descriptive Statistics

Table 1 presents the summary statistics of our input, output and efficiency measures. All variables were winsorized at the 1st and 99th percentile to minimize the effects of outliers[6]. Under the DEA approach, the Islamic banks' TE, PTE, and SE scores were 0.74, 0.83, and 0.90 compared to 0.86, 0.91, and 0.94 of the conventional banks

[5] A list of these 38 banks are given in Appendix.

[6] Our results are robust to not winsorizing the variables.

and 0.91, 0.95, and 0.96 of the mixed banks, respectively. The efficiency score of the conventional, Islamic and mixed banks were 0.98, 0.91, and 0.97, respectively under the SFA approach.

Although our output variable was different from earlier studies, these efficiency scores were comparable to those in Ali (2015) and Hassan (2006). In contrast to their relatively lower efficiency scores, Table 1 shows that Islamic banks have higher deposits, more employees, greater investment and operating income compared to the conventional and mixed banks. However, mixed banks were bigger in size in terms of their fixed assets, and had higher non-investment income compared to the Islamic banks.

Table-1. Descriptive statistics.

Variable	Conventional banks			Islamic banks			Mixed banks		
	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.
Deposit[a]	119	107.40	77.74	54	184.28	160.72	77	157.59	58.11
Employees[b]	119	2.29	1.89	54	3.35	3.85	77	2.46	1.57
Fixed asset[a]	119	2.42	2.16	54	3.87	4.43	77	4.07	2.33
Investment income[a,7]	119	9.68	6.66	54	17.39	13.37	77	13.91	3.87
Non-investment income[a,8]	119	3.77	2.83	54	2.50	2.55	77	5.44	2.27
Operating revenue[a]	119	13.46	9.34	54	19.86	15.67	77	19.35	5.83
TE_DEA	119	0.86	0.12	54	0.74	0.18	77	0.91	0.10
PTE_DEA	119	0.91	0.11	54	0.83	0.19	77	0.95	0.07
SE_DEA	119	0.94	0.07	54	0.90	0.12	77	0.96	0.06
Efficiency_SFA	119	0.98	0.02	54	0.91	0.09	77	0.97	0.02

[a] Billion Bangladeshi Taka; [b] Number of employees in thousand.

4. RESULTS AND DISCUSSION

4.1. The DEA Approach

We set out to estimate and compare operating efficiency among Islamic, conventional, and mixed banks in Bangladesh. In our previous section, we presented the efficiency scores: technical, pure technical, and scale efficiency; using the DEA approach. In this section, we compared these efficiency scores across the three categories of banks.

4.2. Technical Efficiency (TE)

Table 2A presents one-way ANOVA results where we tested if there were statistically significant differences among the three categories of banks in terms of their TE. We saw that the F value was statistically significant at the 1% level. In Bartlett's test, we also rejected the null hypothesis that the variance in TE among the three bank groups was equal. Hence, at least two groups of banks were different in their TE in our sample. Since one-way ANOVA does not tell which specific group's TE is significantly different from each other, we ran the Bonferroni test.

Table 2B depicts that the Islamic banks' TE was significantly lower than that of the conventional banks. On the other hand, the mixed banks' TE was significantly higher than that of the conventional and Islamic banks. This means that the Islamic banks' TE was lower than those of both the conventional and mixed banks in our sample.

[7] Commonly known as interest income.

[8] Commonly known as non-interest income.

Table-2A. One-way ANOVA.

Source	SS	Df	MS	F	Prob > F
Between groups	0.99	2.00	0.49	28.98	0.00
Within groups	4.20	247.00	0.02		
Total	5.19	249.00	0.02		

Bartlett's test for equal variances: chi^2 = 21.86 Prob>chi^2 = 0.00.

Table-2B. Multiple comparison (Bonferroni test).

Banks	Conventional banks	Islamic banks
Islamic banks	-0.12***	
Mixed banks	0.06***	0.18***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

4.3. Pure Technical Efficiency (PTE)

Table 3A exhibits the results comparing the Islamic, conventional and mixed banks' PTE using one-way ANOVA. Similar to our findings for TE, Table 3A shows that at least two groups of banks' PTE were significantly different from each other. Again, the presence of difference was supported by the Bartlett's test. The multiple comparison test in Table 3B indicates a similar story. The Islamic banks' PTE was significantly lower than those of both the conventional and mixed banks. In addition, mixed banks were superior to the conventional banks in achieving PTE.

Table-3A. One-way ANOVA.

Source	SS	df	MS	F	Prob > F
Between groups	0.43	2.00	0.22	14.65	0.00
Within groups	3.65	247.00	0.01		
Total	4.08	249.00	0.02		

Bartlett's test for equal variances: chi^2 = 70.02 Prob>chi^2 = 0.00.

Table-3B. Multiple comparison (Bonferroni test).

Banks	Conventional banks	Islamic banks
Islamic banks	-0.08***	
Mixed banks	0.04*	0.12***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

4.4. Scale Efficiency (SE)

Table 4A presents the test results on whether the three types of banks have a similar SE. Once again, we found a similar story except that the mixed banks' SE was not statistically different from that of the conventional banks, but it was significantly greater than that of the Islamic banks. Similar to the TE and PTE results, the Islamic banks' SE was lower than that of the conventional banks which was statistically significant at the 1% level (Table 4B).

Table-4A. One-way ANOVA.

Source	SS	df	MS	F	Prob > F
Between groups	0.13	2.00	0.07	10.71	0.00
Within groups	1.52	247.00	0.01		
Total	1.65	249.00	0.01		

Bartlett's test for equal variances: chi^2 = 37.84 Prob>chi^2 = 0.00.

Table-4B. Multiple comparison (Bonferroni test).

Banks	Conventional banks	Islamic banks
Islamic banks	-0.04***	
Mixed banks	0.02	0.06***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

4.5. Additional Analyses

In this section, we decomposed our output variable (i.e., total operating income) into investment income and non-investment income to examine whether Islamic banks were less efficient than the conventional and mixed banks in both of these income segments. Table 5 and 6 present the results.

Table-5. Multiple comparison test for investment income.

Banks	TE		PTE		SE	
	Conventional banks	Islamic banks	Conventional banks	Islamic banks	Conventional banks	Islamic banks
Islamic banks	0.008		0.007		0.002	
Mixed banks	0.05*	0.04	0.02	0.01	0.03***	0.03

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

In Table 5 we compared the Islamic, conventional, and mixed banks' TE, PTE, and SE in terms of their investment income. Surprisingly, Islamic banks were as efficient as the conventional and mixed banks in all three efficiency measures. Only mixed banks were more efficient than conventional banks except in PTE.

Table-6. Multiple comparison test for non-investment income.

Banks	TE		PTE		SE	
	Conventional banks	Islamic banks	Conventional banks	Islamic banks	Conventional banks	Islamic banks
Islamic banks	-0.39***		-0.35***		-0.08***	
Mixed banks	0.13***	0.52***	0.13***	0.48***	0.01	0.09***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

Table 6 presents the comparative results for the Islamic, conventional, and mixed banks' TE, PTE, and SE in the non-investment income segment. In contrast to what we have seen in Table 5, the Islamic banks fell short to the conventional and mixed banks in all three dimensions of efficiency. Similar to the case of investment income, the mixed banks maintained their superiority in attaining efficiency over the conventional banks. Overall, Table 5 and 6 imply that the Islamic banks' inefficiency was driven by their non-investment income rather than investment income.

4.6. Subsample Analyses

In this section, we examined if the Islamic banks' efficiency is diminishing over time compared to those of conventional and mixed banks. As you may recall from our introduction the Islamic banks' net profit margin has been showing a downward trend in the recent years. Since research shows that a firm's operating efficiency is positively related to current and future performance (e.g., Baik *et al.* (2013)) a decrease in net profit margin could be the result of a decline in Islamic banks' operating efficiency compared to other banks.

To diagnose this possibility, we compared the average efficiency scores of the three latest and three earliest years in our sample window (i.e., average of 2015 to 2017 and of 2011 to 2013) for all three categories of banks. Table 7 shows the results.

Table-7. Comparison of efficiencies.

Panel A: Multiple comparison test of difference in TE.

Banks	2011 to 2013		2015 to 2017	
	Conventional banks	Islamic banks	Conventional banks	Islamic banks
Islamic banks	-0.10**		-0.14***	
Mixed banks	0.09**	0.18***	0.03	0.17***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

Panel B: Multiple comparison test of difference in PTE.

Banks	2011 to 2013		2015 to 2017	
	Conventional banks	Islamic banks	Conventional banks	Islamic banks
Islamic banks	-0.07		-0.08**	
Mixed banks	0.06	0.13***	0.02	0.08***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

Panel C: Multiple comparison test of difference in SE.

Banks	2011 to 2013		2015 to 2017	
	Conventional banks	Islamic banks	Conventional banks	Islamic banks
Islamic banks	-0.04		-0.06***	
Mixed banks	0.03	0.06***	0.01	0.07***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

According to Table 7 there was no significant difference in the Islamic and conventional banks' average PTE (Panel B) and SE (Panel C) for the period of 2011 to 2013, although the TE (Panel A) of the Islamic banks was 10% lower than that of the conventional banks which was statistically significant at the 5% level. However, this scenario changes later on.

For the period from 2015 to 2017, the Islamic banks lagged behind the conventional banks in all three dimensions of efficiency. The gap in the TE increased to 14% from 10%. The difference in PTE and SE became statistically significant. The mixed banks, on the other hand, dominated over the Islamic banks both for the earliest and the latest periods[9]. Therefore, we inferred that the decline in the Islamic banks' operating efficiency could be one of the reasons behind the increasing difference in their net profit margin compared to the other banks in recent times.

4.7. The SFA Approach

So far the results of the DEA approach showed us that the Islamic banks were less efficient compared to the conventional and mixed banks in Bangladesh. However, the DEA approach does not allow for symmetric random noise in measuring (in)efficiency (Baik *et al.*, 2013). In this section we checked the robustness of the DEA based results by using the SFA approach. As we mentioned earlier, we measured SFA based efficiency scores by including year dummies in our estimation process. Table 8 and 9 present the results.

Table-8. One-way ANOVA.

Source	SS	df	MS	F	Prob > F
Between groups	0.17	2	0.09	36.83	0.00
Within groups	0.59	247	0.002		
Total	0.76	249.00	0.003		

Bartlett's test for equal variances: chi^2 = 190.54 Prob>chi^2 = 0.00.

Table-9. Multiple comparison (Bonferroni test).

Banks	Conventional banks	Islamic banks
Islamic banks	-0.07***	
Mixed banks	0.004	0.06***

*** Significant at the 0.01 level; ** Significant at the 0.05 level; * Significant at the 0.10 level.

The results in Table 8 suggest that at least two groups of banks were different in terms of their efficiency levels. Like in the previous sections, we used the Bonferroni test to identify which two groups of banks were

[9] These results remain qualitatively similar if we compare the efficiency scores of Islamic, conventional, and mixed banks for the latest two and earliest two years in our sample window.

different. As Table 9 shows, the Islamic banks' level of efficiency was 7% lower than that of the conventional banks. Similarly, the efficiency of mixed banks was 6% greater than that of the Islamic banks which means Islamic banks fell short to mixed banks as well. These results were consistent with what we found earlier using the DEA approach.

The efficiency of mixed and conventional banks was not different under the SFA approach, which was inconsistent with the results under the DEA approach where we found that mixed banks were more efficient in two of the three measures of efficiency. This difference could be because of the random shock that the DEA approach does not capture. Overall, the SFA results confirmed our earlier findings from the DEA approach that the Islamic banks in Bangladesh were less efficient than the conventional and mixed banks.

5. SUMMARY AND CONCLUSION

In this paper, we provided evidence on the Islamic banks' diminishing efficiency compared to other private commercial banks in Bangladesh. While several prior studies examined the operational efficiency of Islamic, conventional and mixed banks either in isolation or in combination, hardly any of these used the banks' operating revenue as the output variable in their frontier analysis. Therefore, we know little about the banks' efficiency in terms of generating revenues by using their resources.

Prior studies also predominantly used the DEA approach which does not account for the random noise in efficiency estimation. Hence, the results of the earlier studies suffer from an inherent limitation. This study addressed these issues by using the revenue as the output variable, and measuring efficiency using both the DEA and SFA approaches.

Using 250 observations for the years from 2011 to 2017, we provided evidence that the Islamic banks in Bangladesh were less efficient than the conventional and mixed banks in generating revenue from their resources. This DEA based result was robust to measuring efficiency under the SFA estimation as well. In further analysis, we found that the inefficiencies of Islamic banks were driven by their non-investment revenues rather than investment income. This suggested that there are opportunities for Islamic banks to improve their efficiency in areas other than investment activities.

One such way to improve efficiency could be finding more standardized financial instruments (Alam *et al.*, 2019). Without such improvements, the Islamic banks might be facing challenges in near future, especially in collecting deposits, in the rapidly growing and competitive banking industry in Bangladesh. Therefore, our findings have relevance and implications for the management of Islamic banks.

This study could further be extended by examining the drivers of relative inefficiency of the Islamic banks in Bangladesh. As prior research documents, this relative inefficiency could be driven by their internal control weaknesses (see Cheng *et al.* (2018) for instance). Examining the relationship between the banks' efficiency and their executives' compensation would also be a worthy contribution to this line of research.

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Appendix: List of sample banks.

SN	Bank	Type	SN	Bank	Type
1	Bangladesh Commerce Bank Ltd	Conventional	20	Al-Arafah Islami Bank Ltd	Islamic
2	BRAC Bank Ltd	Conventional	21	EXIM Bank Ltd	Islamic
3	Dutch-Bangla Bank Ltd	Conventional	22	First Security Islami Bank Ltd	Islamic
4	Eastern Bank Ltd	Conventional	23	ICB Islamic Bank Ltd	Islamic
5	IFIC Bank Ltd	Conventional	24	Islami Bank Bangladesh Ltd	Islamic
6	Meghna Bank Ltd	Conventional	25	Shahjalal Islami Bank Ltd	Islamic
7	Mercantile Bank Ltd	Conventional	26	Social Islami Bank Ltd	Islamic
8	Midland Bank Ltd	Conventional	27	Union Bank Ltd	Islamic
9	Modhumoti Bank Ltd	Conventional	28	AB Bank Ltd	Mixed
10	Mutual Trust Bank Ltd	Conventional	29	Bank Asia Ltd	Mixed
11	National Bank Ltd	Conventional	30	Dhaka Bank Ltd	Mixed
12	National Credit & Commerce Bank Ltd	Conventional	31	Jamuna Bank Ltd	Mixed
13	NRB Bank Ltd	Conventional	32	Premier Bank Ltd	Mixed
14	NRB Commercial Bank Ltd	Conventional	33	Prime Bank Ltd	Mixed
15	NRB Global Bank Ltd	Conventional	34	Pubali Bank Ltd	Mixed
16	One Bank Ltd	Conventional	35	Southeast Bank Ltd	Mixed
17	South Bangla Agriculture & Commerce Bank	Conventional	36	Standard Bank Ltd	Mixed
18	United Commercial Bank Ltd	Conventional	37	The City Bank Ltd	Mixed
19	Uttara Bank Ltd	Conventional	38	Trust Bank Limited	Mixed