Efficiency of Banks in Bangladesh: A non-parametric Approach

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Abstract

This paper measures and analyses the efficiency of commercial banks in Bangladesh using data envelopment analysis. The data consist of accounting figures of 43 banks in 2003. On average, the technical efficiency score of banks in the sample is 84 percent (income-based model) and 80 percent (user-cost model), which is consistent with results from a parametric approach called parametric linear programming. The market share (proxy by share of total loans) is positively and significantly influenced by technical efficiency. However, the evidence on the relationship between foreign ownership and bank efficiency is not significant for the income-based model.

1. Introduction

Improving the efficiency of the banking sector has been considered an important issue in Bangladesh. In 1986, the Government formed the national commission on money, banking and credit to find solutions for efficient operation and management of the banking system. In addition, in 1991 a taskforce was formed to formulate strategies to promote the development of banking and financial sector. In the same period, the World Bank assisted conducting several studies on banking sector reform in Bangladesh (Shameem, 1995). Based on the experience during the 1986-1991 period and suggestions from World Bank's studies, the central bank of Bangladesh, Bangladesh Bank (BB), adopted further reforms such as strengthening the role of the central bank in supervision and regulation.

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The need for further improvement of the banking sector continues. Recently, the Governor of BB stressed the need for an efficient banking sector. The BB also urged that more research on the banking sector of Bangladesh needs to be conducted. Meanwhile, no previous study, to the best of our knowledge, has examined the efficiency of commercial banks in Bangladesh.

To fill in the gap of research, this study is conducted to measure and to analyse the efficiency of commercial banks in Bangladesh. The main objective of this study is to analyse the efficiency of Bangladesh commercial banks and identify determinants of efficiency.

2. An Overview of the Bangladesh Banking Sector

The banking sector in Bangladesh comprises four types of banks, viz. nationalised commercial banks (NCBs), government-owned specialised banks (DFIs), private commercial banks (PCBs), and foreign commercial banks (FCBs). The Bangladesh banking sector is dominated by NCBs in terms of asset value. However, since 2003 the market share of NCBs on the asset side declined substantially while that of PCBs increased remarkably. Particularly, NCBs share declined to 41.7 percent of the total assets as against 45.6 percent in 2002 while PCBs share rose to 40.8 percent in 2003 as against 36.2 percent in 2002. Foreign commercial banks held 7.3 percent of the industry assets in 2003, showing a slight increase by 0.5 percentage point over the previous year.

The NCBs' dominance on the deposit side also was on a declining trend because of the rapid increase in deposits of other banks. For example, while the total deposits of NCBs rose by 11.4 percent, their share in the deposit market declined from 50.3 percent in 2002 to 46.0 percent in 2003. In contrast, PCBs' deposits in 2003 accounted for 41.1 percent of the total industry deposits as against 36.8 percent in 2002 (NBB, 2003; 2004).

In general, the performance of the banking sector in Bangladesh improved constantly with the passage of time. Table 1 shows the ratio of net non-performing loans to total loans of the period of 1997-2003. Ironically, government owned banks, with large asset share and an extensive network, have always had the highest rate of non-performing loans. One possible reason is that government banks, such as NCBs, have to allocate credit through directed lending programs to certain economic sectors dictated by the government (NBB, 2001). In contrast, FCBs, despite their modest share in total industry's asset, always maintained the lowest rate of non-performing loans amongst commercial banks in Bangladesh

(Table 1). Perhaps, international experience, technology and advantage helped FCBs outperform their domestic counterparts in this category.

Table 1 : Ratio of net non-performing loans to total loans by type of banks

Bank types	1997	1998	1999	2000	2001	2002	2003
Nationalised commercial banks	31.4	35.6	41.3	34.1	32.8	30.1	28.3
Government specialised banks	57.0	59.1	58.5	54.6	54.5	48.0	38.4
Private commercial banks	25.1	26.3	21.2	15.5	10.5	10.5	8.3
Foreign commercial banks	-0.5	0.1	0.9	-0.1	-0.3	-0.4	0.00
Total	30.7	34.4	35.6	28.8	25.6	22.6	18.8

Source: Bangladesh bank, 2004

The efficiency measurement of commercial banks in Bangladesh is made by using partial productivity indicators or a combination of these indicators with qualitative measurement (i.e., the CAMEL[1] rating system). Based on the CAMEL scores and off-site supervision tools, the National Bank of Bangladesh (NBB) a private commercial bank, introduced warnings and suggestions for poorly performing banks to help them come back on the right track. However, comprehensive investigation on efficiency of commercial banks using a scientific approach has not been conducted in Bangladesh previously.

3. Methodology

Efficiency analysis methods can be classified into two main approaches, namely, parametric approach and non-parametric approach. The parametric approach such as Stochastic Frontier Analysis (SFA) is characterized with a composite error term of the estimated production function. This composite error term consists of a random error component and a non-negative inefficiency component. The advantage of SFA is the inclusion of a random noise in the analysis. Meanwhile, its main drawback is the sensitiveness of results on assumption of functional form and the distribution of the inefficient component.

[1] CAMEL stands for Capital adequacy, Asset quality, Management soundness, Earnings and profitability, and Liquidity. It includes some quantitative indicators such as return on asset, return on equity and some qualitative indicators such as asset quality.

The non-parametric approach such as Data Development Analysis (DDA) is a data-driven approach. The DDA terminology was first developed by Charnes *et al.* (1978) although the concept originated from the work of Farrell (1957). DDA involves the calculation of efficiency by comparing the input/output ratio of each firm with a piecewise surface, representing fully efficient operation, constructed from the data set by linear programming. DDA can be measured by an input-oriented process, which focuses on reducing inputs to produce the same level of outputs, and an output-oriented process, which aims to maximize outputs from the same set of inputs[2]. The main drawback of DDA is the assumption of no random error in the data. However, DDA assumes no functional form or distributional assumptions of the inefficiency component. In addition, DDA provides useful managerial information of peers, which are inefficiency firms of similar input-output structure with fully efficient firms. Due to this handy managerial information and its increasing popularity in banking study, DDA is the selected approach in this study. DDA is also selected for the ability of handling multi-outputs and multi-inputs setting. In addition, DDA made no assumption on production function and distributional forms of the error term. Another reason for choosing the DDA approach is its comparative robust (Seiford and Thrall, 1990).

As mentioned before, DDA can be applied by input-oriented approach or output-oriented approach. In this study, the input-oriented approach is selected arbitrarily. Moreover, it is often easier for banks to control production inputs (e.g., wages and other operational costs) whilst there are many factors influencing outputs (e.g., loans) that banks have no control over. Thus, the input-oriented approach is likely more practical.

Apart from DDA, we use a parametric method named parametric linear programming (PLP) in the analysis for comparison. The PLP technique involves specifying a parametric functional form for the production technology then using linear programming to select parameter values so that the frontier provides the "closest" fit over the sample data (Coelli and Perelman, 1999). To avoid the shortage of degree of freedom in the PLP technique with small number of observations in this study (43 banks), a modified version of the input distance function translog PLP, which drops the interaction within outputs and inputs and between inputs and outputs, is used.

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2 For more detaied descriptions on DDA, see Coelli et al. (1998)

4. Data and variable selections

4.1 Data

This study uses the data from annual report 2003 of 48 Bangladeshi banks. The data include major items in the balanced sheet of banks such as costs (e.g., labour costs, interest costs, and other costs), deposits (e.g., demand deposit and time deposit), loans, assets and capital. There is no information on physical measurement of production factors such as labour, materials and machinery. Instead, only value-term of these factors occurred in the 2003 financial year was recorded. The shortage of physical measurement data such as number of employees, number of computers, ATMs, etc. and price data has created difficulties for this study to investigate the issue of allocative efficiency.

There is a high degree of variation among variables. Most of the variables have their standard deviation greater than their means. A huge fluctuation of proxy for size such as total assets is also observed in many other banking efficiency studies such as Aly *et al*. (1990). However, there are some questionable zero values among common variables, particularly key inputs such as labour, borrowings and depreciations. As the zero values of input violate the basic assumption of a production function, banks with zero values of inputs are excluded from the analysis. Therefore, the final data set in this study includes only 43 banks.

4.2 Selection of Variables

There are two main approaches in efficiency measurement of financial institutions, namely the production approach and the intermediation approach. The production approach considers financial institutions as production units that use standard inputs (e.g., labour, materials and machinery) to produce financial transactions (often measured by number of saving and loan accounts). Meanwhile, the intermediation approach considers microfinance institutions as intermediators between savers and investors. The intermediation approach includes financial inputs such as deposits, loanable funds[3] and dollar value of transaction in the outputs. Because there is no information on the number of labour, number of accounts and number of customers, this study follows the intermediation approach. According to Berger and Humphrey (1997), the intermediation approach has the advantage of taking into account the interest cost, which can contribute up to two thirds of total cost in the banking sector.

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[3] For more details about production and intermediation approaches, see, for example, Berger and Humphrey (1997).

From the data available, two efficiency estimation models were selected (Table 2). Model 1 follows the income-based specification as applied by Akiran (1999, 2000), and Sturn and William (2004). This model considered microfinance institutions that use interest expenses (expenditure on interest of deposits and borrowed funds) and non-interest expenses to generate net interest income and non-interest income. Model 2 classified inputs and outputs based on the user costs framework specified by Hancock (1986). Particularly, this model includes three inputs: labour cost, capital (book value of premises and fixed assets), and loanable funds (time deposit, demand deposit, and borrowed funds); and two outputs: total loans, and demand deposit.

Table 2 : Model specifications

Models	*Inputs*	*Outputs*
Model 1	Interest expenses	Interest income
	Other expenses	Non-interest income
Model 2	Labour cost	Total loans
	Capital	Demand deposit
	Loanable fund	

In order to identify determinants of efficiency, the study investigates the size of banks and market power (measured by the ratio of loans of a bank to total loans of banks in the sample), ownership (foreign dummy variable, 1=foreign banks and 0=otherwise), and technology (measured by the ratio of non-labour cost to total cost). It is expected that banks with higher technology have a higher ratio of non-labour cost over total cost. Also, the size and market power variables have a positive sign since big and powerful banks are likely efficient ones. This seems to be an obvious assumption given the merger and acquisition trend in the banking industry worldwide. We do not assign any expected sign for the ownership variable because it can be positive (i.e., foreign banks often have superior technology) or negative (i.e., foreign banks often lack local knowledge to work efficiently). The technology variable is expected to have a positive sign because banks with higher technology (i.e., higher ratio of non-labour cost to total costs) is likely more efficient.

The descriptive statistics of selected variables presented in Table 3 show that there is a huge variation amongst banks in the sample in terms of size, power, inputs used and outputs produced. This reflects the fact that in the banking industry the

gap between big and small banks can be thousands of times. In most variables, the mean is bigger than the median, showing only a few mega banks in the sample whilst the remaining banks are small. The data also show that, on average, foreign banks account for 21 percent of banks in the sample.

Table 3 : Descriptive statistics of selected variables

Name	*Mean*	*Median*	*Minimum*	*Maximum*
Interest income	1363.57	796.38	0.24	10558.51
Non interest income	529.68	173.06	6.43	5324.90
Interest expenses	1109.67	520.73	7.49	11958.97
Non-interest expenses	442.35	204.86	13.36	3433.04
Total loans	13896	5132	13	141993
Demand deposit	6001	1354	2	66386
Labour cost	278	86	6	2601
Capital	529	288	80	3272
Loanable fund	17220	8388	70	181991
Loan share (percent)	2.33	0.86	0.002	23.7
Ownership (dummy)	0.21	0.00	0.00	1.00
Technology (percent)	88.40	89.58	75.24	95.89

Note: Unless otherwise specified, the variables are measured in billion of Taka.

5. Results and Discussions

This study uses the DEAP computer program developed by Coelli (1996) to calculate the efficiency of Bangladesh commercial banks in the sample. The results of DDA estimates presented in Table 4 show that, on average, the overall efficiency score of commercial banks in the sample is 64 percent (Model 1) and 67 percent (Model 2). The overall efficiency score comprises of 84 percent of technical efficiency, and 77 percent of scale efficiency (Model 1). Meanwhile, Model 2 decomposes the overall efficiency into 80 percent of technical efficiency, and 83 percent of scale efficiency. That means, average commercial banks in Bangladesh can improve their efficiency by some 20 percent with better input-output structure (i.e., technical efficiency), and around another 20 percent by adjusting to the most effective production scale. While the production scale can only be adjusted on a long-term basis, components of technical efficiency are daily managerial factors. Therefore, technical efficiency is more a practical issue and will be the focus of this study. The focus of this study on technical efficiency

in also based on findings from previous studies such as Berger et al. (1993), which argued that technical efficiency accounts for around 20 percent of costs in banking whilst scale efficiency accounts for just 5 percent.

Table 4 : Descriptive statistics of Efficiency Scores

Models	*Categories*	*Mean*	*Median*	*Std.*	*Min*	*Max*
Model 1	Overall efficiency	0.64	0.16	0.63	0.37	1.00
	Technical efficiency (DDA)	0.84	0.17	0.88	0.42	1.00
	Scale efficiency	0.77	0.17	0.78	0.43	1.00
	Technical efficiency (PLP)	0.83	0.14	0.84	0.52	1.00
Model 2	Overall efficiency	0.67	0.23	0.69	0.05	1.00
	Technical efficiency (DDA)	0.80	0.21	0.84	0.09	1.00
	Scale efficiency	0.83	0.19	0.89	0.27	1.00
	Technical efficiency (PLP)	0.81	0.20	0.87	0.35	1.00

On average, the improvement of technical efficiency by 20 percent can be translated into a total cost saving of 17,000 million BDT. However, as mentioned by Avkiran (1999), DDA provides insights on which areas need to be improved but it does not have information on how to improve. Further investigations are needed in order to identify approaches for each bank to save costs by moving towards the efficient frontier.

The average overall efficiency score of Bangladesh banks (64-67 percent) is lower than the average efficiency score (86 percent) of some international studies reviewed by Berger and Humphrey (1997). According to the argument of Sathye

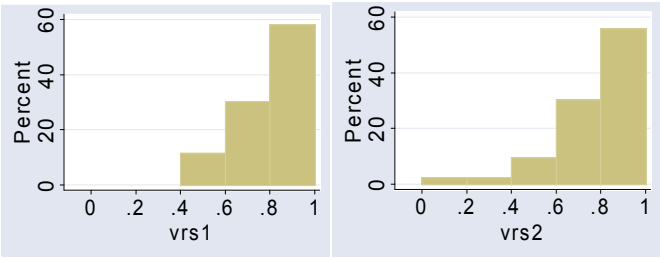

Figure 1: Histograms of technical efficiency scores estimated by DDA

(2001), there is ample room for commercial banks in Bangladesh move towards the frontier of world's best practice. Thus, there is a need for the Bangladesh government to create a more favourable environment for the development of banking sector.

Although the distribution of technical efficiency scores of Bangladesh commercial banks estimated by both models are very similar (Figure 1), they produce a different ranking, meaning the frontier of Model 1 and Model 2 contain different banks. This is one of the characteristics of DDA that results may be sensitive to the selection of variables. However, this can also be considered a strength of DDA (Avkiran, 1999) since it can mimic managers about factors to improve. In the case of this study, DDA results show that the importance of efficient banks (i.e., banks that were referred to many times as peers for inefficient banks) may differ between Model 1 and Model 2. For example, the Islami Bank Bangladesh is considered to have an influential role under Model 2 with 23 times referred to as a peer. Meanwhile, under Model 1 it was referred to as a peer only 3 times (Table 5).

Table 5 : Important Banks under different models

Name of the bank	Number of Peers	
	Model 1	Model 2
Dutch-Bangla Bank Ltd	8	5
Bangladesh Shilpa Bank	13	1
Islami Bank Bangladesh Ltd.	3	23
BRAC Bank	1	8
National Bank of Pakistan	3	13
Uttara Bank Ltd	6	4

The PLP estimate shows that the average technical efficiency scores of commercial banks in this study, estimated by Model 1 and Model 2 are 83 percent and 81 percent, respectively (see Table 4). The range of efficiency scores estimated by PLP is closer, compared to that of DEA. For example, the range of technical efficiency scores estimated by DDA (Model 2) is from 9.2 to 100 percent whilst the relative figures estimated by PLP technique are 35 percent to 100 percent. The introduction of a random noise component has made it less volatile as in DDA models.

The determinants of efficiency were estimated by Tobit regressions since the values of dependent variables (i.e., efficiency scores) are bounded between zero and one. The results presented in Table 6 show that the share of loans is positively and significantly related to technical efficiency of commercial banks in the samples. That means, banks that have more market power (i.e., have larger share in the loan market) are technically more efficient. One reason may be that larger banks have higher technology or superior management, and thus, according to Berger (1995), have lower costs. As can bee seen, the non-labour variable in Table 7 has positive sign in both models, although it is not significant. That means, banks with higher ratio of non-labour cost over total costs, which is often due to higher technology, are likely more efficient.

Table 6 : Determinants of Technical Efficiency

Variables	Model 1	Model 2
Share of loans	*0.03	*0.03
	(0.06)	(0.07)
Non-labour ratio	0.77	1.01
	(0.32)	(0.28)
Foreign	0.06	**0.25
	(0.57)	(0.04)
Constant	0.14	-0.13
	(0.83)	(0.87)
	Pseudo R^2=0.19	*Pseudo R^2=0.20*
	Uncensored n=27	*Uncensored n=28*

*Note: p-value are in the parentheses, * represent 10% and ** represent 5% significant*

The ownership variable suggests that foreign banks are likely more efficient than domestic counterparts. However, this variable is only significant on Model 2. The average technical efficiency scores of domestic banks and foreign banks (Table 7) also support this finding. Particularly, while in Model 1 the technical efficiency scores of domestic and foreign banks are very close (84 percent and 83 percent, respectively), in Model 2, the average technical efficiency of foreign banks (88 percent) is much higher than that of domestic banks (78 percent). One possible reason for foreign banks to be more efficient than domestic counterparts in Bangladesh may be the superior management and advanced technology since most foreign banks in this sample come from more developed countries (e.g., the Netherlands, USA, etc). However, foreign banks also face difficulties of not being

familiar with the culture and local business environment. That may be one reason why the evidence is not significant in Model 1.

Table 7 : Comparison between domestic and foreign banks

Models	Average technical efficiency score		One-way ANOVA	
	Domestic (n=34)	*Foreign (n=9)*	*F-test*	*p-value*
Model 1	0.84	0.83	0.03	0.87
Model 2	0.78	0.88	1.42	0.24

In order to identify if the two samples (domestic and foreign banks) are drawn from the same population, we conducted an analysis of variance (ANOVA) test. The test results reject the null hypothesis (Table 7). Therefore, it is appropriate to construct a combined production frontier from the two samples (Sathye, 2001).

6. Conclusions

This study has investigated the efficiency of commercial banks in Bangladesh using DDA with an income-based model and a model on user's costs framework. The results show that, on average, the overall technical efficiency of Bangladesh commercial banks is 67 percent, which is below the average estimated by international studies reviewed by Berger and Humphrey (1997). Thus, there is ample room for Bangladeshi government and bank managers to improve the performance of the industry to catch up with the world's best practices. However, it is worth to note that frontiers from different studies may be constructed from different data set.

Results of the second-stage regressions support the hypothesis that larger and/or more powerful banks are likely more efficient owing to advanced technology and superior management. This may also be the reason that foreign banks are more technically efficient although the evidence is not significant under Model 1. Thus, attracting more foreign technology in banking by creating favourable environment for foreign investors may be one of the factors to improve efficiency.

There are several other limitations of this study. Firstly, we do not have access to data on price and other environment factors. In addition, the study does not have access to panel data available, making it impossible to decompose the overall efficiency into catching-up component and the shift of production frontier. The study also found no previous studies on efficiency of commercial banks in Bangladesh to make a comparison.

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