

Performance Measurement of Commercial banks of Bangladesh: An Application of Two Stage DEA Method

A. F. M. Ataur Rahman¹

The efficiency calculations for banking companies face a steep criticism from practitioners in the ground that while banking is a multi stage operation, a single efficiency score obtained from certain efficiency calculating exercise is not sufficient to capture the status of a bank completely. Following this motivation in this paper we applied two stage DEA, where we have decomposed the operation of banks in two parts. The first part concentrates on loan intermediation and the second part concentrates on technical soundness of the institutions. Following this approach we calculated efficiency scores of 42 commercial banks of Bangladesh at the end of 2008. We have found that banks as groups are more or less homogeneous in intermediation with nationalized banks having an edge. But in technical part banks are more heterogeneous and foreign banks outperform local banks.

Keywords: Two stage DEA, Commercial bank, Efficiency

JEL Codes: G14 and G21

1. Introduction

Financing productive activities is one of the most important tasks of an economy. This can be accomplished either through intermediaries or through markets (stock markets to be specific). In Bangladesh, intermediary (primarily, banks) financing is more common than market financing. Commercial banks can be considered as the stem of financial services industry of Bangladesh. However, banks in Bangladesh, as a class of institutions are not homogeneous. They come in different sizes, capacities and preferences. Some prefer to operate in urban areas, some deliberately work in rural areas, some have specific preference towards agricultural farmers, some towards SME, some towards non-agricultural cottage industry and so on. There are some foreign banks operating in Bangladesh, who primarily focus their operations with their parent country. So when question comes to compare commercial banks with respect to their operational efficiency based on same set of criteria, it becomes difficult. To mitigate this problem the modeler needs to be extra careful while selecting methodology and variables concerned.

Another problem arises while measuring efficiency of commercial banks from the fact that banks are a complex type of financial institutions and they are engaged in many kinds of activities. A single efficiency score may not be sufficient to capture all peculiarities of its operation. A multi-measure efficiency score may be more suitable for commercial banks.

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Keeping these two peculiarities in mind we have chosen two stage Data Envelopment Analysis (DEA) method for determining efficiency score of Bangladeshi commercial banks. In this method we calculate efficiency in two steps producing two scores which then merge into one. This methodology is well established in literature, however the current paper adds to the literature by applying this method in efficiency calculation of Bangladeshi banks which gives the modeler the flexibility to treat certain variable both as input and output. To the best of our knowledge this method has not been applied in any definition to investigate efficiency issue of Bangladeshi commercial banks.

The rest of paper is organized in the following way; the next section discusses relevant literature followed by a discussion on methodology in the subsequent section. The section after that discusses data sources. Then in a separate section results obtained are discussed and the paper concludes with the concluding section. A small discussion on Bangladeshi banking system is placed after literature review.

2. Literature Review

The commonly used techniques to compare efficiency of banking companies are ratios analysis (Sarker, 1999), use of financial indices (Coelli et. al, 1998), regression analysis (Murphy and Orgler, 1982, Berger et. al 1998, Hensel, 2003), Stochastic Frontier Analysis (SFA) (Fries and Taci, 2005 and Bonin et al, 2005), Free Disposable Hull (FDH), Data Envelopment Analysis (DEA) etc. DEA method although the latest addition in the list is by far the most widely used method of efficiency calculation. DEA is a non parametric method that compares firms producing comparable goods in an input output setup. The outline of DEA was originally proposed in Farrell (1957). Later Charnes et al. (1978) modified the methodology for input orientation assuming constant returns to scale (CRS). Based on this model Banker et al. (1984) developed an algorithm to handle the assumption of variable returns to scale (VRS). With the capacity of handling CRS and VRS assumptions, DEA models have become sufficiently strong and have developed as a point of interest of many researchers. Subsequently these researchers contributed in its theoretical development as well as applied DEA in efficiency calculation exercises. VRS assumption produces pure technical efficiency scores and CRS efficiency score gives total efficiency scores which combines technical as well as scale efficiency. DEA has been extensively used to calculate efficiency of financial institutions. Researchers of many countries have applied DEA to measure efficiency of their local banking industry. DEA method has been used in efficiency calculation of Bangladeshi banking industry as well (Chowdhury and Rahman 2011). In this paper we will try to apply an improved variation of basic DEA model which we will call two stage DEA.

There are a number of studies published in past decades that investigated the issue of bank efficiency for different countries. Berger and Humphrey (1997) has a comprehensive survey of studies published before their survey. Their survey presented around 130 studies that applied varieties of method to calculate efficiency of financial institutions in many countries. However majority of these studies are done on US banking sector. Chowdhury and Rahman (2011) compiled few such studies published after their survey along with some of the important details of those studies in their appendix. Most studies presented in Chowdhury and Rahman (2011) and Berger and Humphrey (1997) have used data envelopment analysis (DEA) and

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have found the presence of heterogeneity in efficiency among banking companies operating in local markets. However, as we know DEA calculates relative efficiency rather than absolute efficiency, it gives efficiency score of a certain firm relative to its peer group included in that study. Any change in its environment will change DEA efficiency scores as well. So heterogeneity in DEA perspective means some banks are more efficient than others.

3. Bangladeshi Banking System

Banking sector of Bangladesh was inherited from Pakistani banking system in 1971 when it earned its independence. However, at that time the whole system was nationalized and socialism was one of the declared and practiced goals of Bangladesh government. Financial sector was (and still is) dominated by banking system. Capital market was virtually non-existent. At that time credit market was fragmented and there were more than thirty different loan categories and every loan application enjoyed one or the other type of privileges. Directed credit, credit with political link was a commonplace. This system obviously produced nothing but the problem of non-performing loans. The ratio of Non-Performing Loan (NPL) soared well over 50%. This figure although very high was actually under-representation of actual situation. This was because the loan classification was rather arbitrary at that time. That arbitrary system was a lot more relaxed than international standard. Soon government realized the need for a massive restructuring in banking sector and subsequently with the help of World Bank it implemented Financial Sector Reform Program (FSRP) in early 1990s. FSRP was proved very beneficial for Bangladeshi banking sector. Among the main recommendations of FSRP we have removal of government control on interest rate and exchange rate, implementing international standard in loan classification, capital adequacy, liquidity requirement, etc. Introduction of private banks although started before the implementation of FSRP, but it got more prominence after the implementation of FSRP a number of private banks came in operation. Currently although private banks have far less number of branches than nationalized banks but in total asset and total deposit comparison they compete with nationalized banks. There are few foreign banks in Bangladesh but they are nowhere compared to asset, deposit, market penetration or any measure related to size or depth.

Currently Bangladeshi banking system is comprised of 48 commercial banks. These banks can be categorized into four different groups. They are Nationalized Commercial Banks (NCB), Specialized Banks (SB), Private Commercial Bank (PCB) and Foreign Banks (FB). All banks are open for public transactions without any bias and preference except specialized banks that operate primarily for the development of a certain sector or region of the country. Most of the banks operate under neo-classical interest-based system. There are 7 full-fledged Islamic banks in operation. In addition to those 7 banks, most of the conventional banks maintain Islamic windows to cater demand of customers who prefer financial products conforming their religious life.

Below we present some basic characteristics of banking sector.

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**Table 1: Some basic attributes of Bangladeshi banks
(Applicable figures are in billion taka, June 2010)**

Bank type	Nos.	Nos. of Branches	Total Deposit	Total Asset	Excess liquidity ratio	Expenditure-income ratio	ROA ⁱ	NPL ⁱⁱ
NCB	4	3394	952.72	1272.64	17.9	79.8	0.74	20.5
SB	4	1366	177.90	291.37	13.8	96.8	0.22	45.6
PCB	30	2427	1967.78	2539.27	5.2	69.6	2.00	3.7
FCB	9	59	230.68	308.70	17.7	63.1	2.87	2.4
All banks	47	7246	3329.08	4411.98	8.8	73.1	1.58	8.7

The above table clearly shows that banks of different classes are not homogeneous in their operation. The difference is even higher at firm level. So an exercise to determine their relative efficiency bringing them on a platform can be quite useful.

Chowdhury and Rahman (2011) tried to address this issue comprehensively. Using DEA method they calculated relative efficiency of banks operating in Bangladesh from four different perspectives, namely intermediation perspective, production perspective, investor's perspective and regulator's perspective. They calculated technical and scale efficiency scores of all Bangladeshi banks and found that Nationalized Commercial Banks (NCB) outperform private and foreign banks in all four different perspectives. Private Commercial Banks (PCB) outperform foreign banks in all cases except investor's perspective.

Sarker (1999) analyzed performance of the Islamic banks following five different Efficiency criteria like productive efficiency, operational efficiency, allocative efficiency, distributive efficiency and stabilization efficiency of five Islamic banks in Bangladesh operating at the time of the study. He defined these efficiencies by different financial ratios. However, the study did not compare the performance of Islamic banks with non Islamic commercial banks therefore; generalization of the result was not feasible. Ahmad and Hassan (2007) analyzed asset quality, and some financial ratios like net profit margin, net interest income, income to asset ratio, non-interest income to asset ratio and liquidity ratios of commercial banks in Bangladesh for seven years from 1994 to 2001. The study found no basic difference between Islamic banks and private commercial banks in terms of asset quality performance. Private commercial banks showed best performance in the category of operational ratios. Islamic banks on an average were the preeminent performer in terms of lowest non-performing to gross loan ratio, capital funds to total asset ratio, capital funds to net loans ratio, capital funds to short-term loan ratio, capital funds to liabilities ratio, non-interest expense to average asset ratio and most of the liquidity ratios. Rashid & Nishat (2009) showed the financial performance and its deviations among different conventional and Islamic banks in Bangladesh with respect to profitability status, riskiness, performance of Islamic Banks with the industry average and different generations of banks and identified points-of-riskiness for Islamic Banking Sector. The study considered 12 important financial ratios and common size income statement and balance sheet information of Islamic banks for 2001 to 2006. These studies indicate that there is heterogeneity in banking practices in Bangladesh.

4. Methodology

Three most widely used techniques of calculating relative efficiency are regression technique, Financial Ratio Analysis (FRA) and DEAⁱⁱⁱ. In regression technique, modeler makes a critical assumption regarding functional form of the production process. Based on that functional form through statistical techniques parameters are determined and subsequently efficiency is measured. The nice feature of this system is that it allows a separate term in the functional form to manage possible noise in data. But its outcome is correct only to the extent of the correctness of the approximation of production function. There is no way to determine production function with certainty, we can only make assumption. Nevertheless regression technique is used in some researches (see Brissimis et al, 2010).

FRA compares performances of firms based on some predetermined financial ratios. It is a quick and easy to understand procedure mostly to compare certain firm's performance over time. Across firms, it becomes a useful technique only when we have a well defined industry norm. There are many different financial ratios and they do not normally produce consistent results. So choice of ratios becomes important and ranking obtained using FRA is sensitive to the ratios considered. Furthermore, FRA does not produce any cardinal measure rather orders the firms. As a result, sometimes DEA is preferred to FRA.

The method of Data Envelopment Analysis (DEA) has proved itself useful in ranking financial and non financial firms based on their relative efficiency scores calculated using algorithm of DEA. Versatility of DEA method lies in its non parametric nature that treats any economic activity as a production process and analyzes that process in input output setup. This versatility although useful is not a panacea as inputs and outputs of service sectors are not always too obvious.

Regarding inputs and outputs of depository financial firms there are two competing models in literature. One of them is production approach (Sherman and Gold, 1985) and other is intermediation approach (Berger and Humphrey, 1991). In intermediation approach financial firms are considered as intermediaries and consider collecting deposits to fund loans is their main business. In case of production approach financial firms are considered as production units that use capital equipments, labor and other resources to produce loans and deposits. In production approach effort of bank employees to earn profit is considered important. This problem is further complicated by the fact that cross-country studies using DEA face heterogeneous environment. The term environment includes factors that could influence efficiency of a firm, where such factors are not traditional inputs and are not under control of management (Casu and Molyneux, 2003). Such factors can include ownership differences, location characteristics, macroeconomic conditions or government regulation.

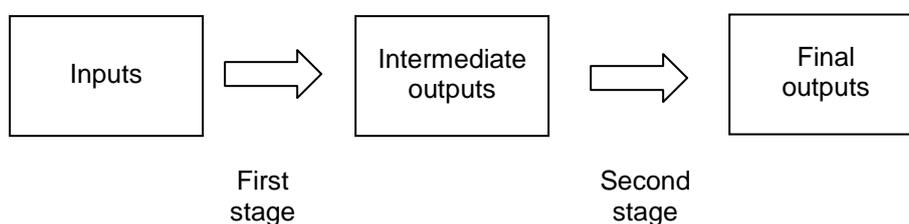
In case of depository financial firms deposit can be considered as output of employees' effort. Good customer care, interpersonal relationship with customers, understanding client's need and devising products accordingly can bring deposits. But collecting deposits is not the only goal of banks rather those are used as input in loan making process. So it is not conceptually clear whether deposit should be treated as input or output. Some of the studies have treated it as input while others considered it as output. The same argument can be extended for total loans as well.

This disagreement is the manifestation of the fact that the banking operation is a multi step procedure. These steps start from deposit collection and end up in profit making. These steps build on one another and in that process the final efficiency of banking companies emerge. All these steps are tightly glued together. It is not possible to consider the whole system efficient while one of its parts is inefficient. Nor it is possible to term the whole system efficient based on the performance of one of its part.

Motivated by this dissatisfaction we have proposed two stage DEA. Here the whole banking operation is separated into two stages, namely stage 1 and 2, they come sequentially and second stage builds on the first. The output of first stage is used as input of the second. In that respect the outputs of first step can be considered as intermediate outputs. It is possible to divide banking operation in several stages but to make things simple and to introduce the main idea of two stage DEA we have divided the process in two simple stages.

Diagrammatically the process can be shown in the following figure:

Figure 1: Schematic diagram of two stage DEA method



Two sets of efficiency scores are produced in these two stages. Efficiency score of the whole system is thus given as the product of these two individual scores. This procedure is nice in the sense that it gives us two separate efficiency measures of two components of the system. By suitably choosing inputs and outputs we can make two efficiency figures meaningful.

Two stage/ three stage DEA terms have been used by many researchers in their studies. However there is no consensus regarding the meanings of these terms in literature. The methodology used here was used previously by Rahman (2007), Kao and Hwang (2008), Chen et al. (2010) Fukuyama and Weber (2010), Fukuyama and Matousek (2010) among others. So this attempt will not add any heterogeneity in this literature.

Paradi, Rouatt and Zhu (2011) used a close variation of this model to calculate bank branch level efficiency scores. In first stage they calculated efficiency score following three different models and in the second stage they compiled those three measures into one measure following DEA technique.

Motivated by the above discussion we now proceed to fix inputs and outputs for two stages. In the first stage we take service orientation. Banks are considered as service institutions where interpersonal skills and careful detailing of financial products can bring output for them. In the second stage banks are considered as technical financial institutions where deposits, borrowings, and loans are converted into net profit. This stage is technical in the sense that if a bank is not sound in its

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money management and does not do its technical analysis properly while selecting loan proposals for financing then it will be difficult for it to earn profit and thus to be considered as efficient. From that perspective it is important for a bank to be efficient in both stages to be considered overall efficient. Decomposition of this efficiency in two parts will make it possible for the managers to find out the source of inefficiency prevailing in the firm.

Implicitly the first measure tells how efficient the management is in serving customers and the second measure tells how efficiently management is handling its loans and deposits. The overall efficiency measure tells how efficiently the whole process is running. The following table gives the input and output specifications of two stages.

Table 2: Input and output variables

First stage		Second stage	
Inputs	Outputs	Inputs	Outputs
Operating expenses (OE)	Total Deposits (TD)	Total Deposits (TD)	Net profit (NP)
Total capital (TC)	Total Loans (TL)	Total Loans (TL)	% of non classified loans (NCL)
Interest expenses (IE)	Total borrowings (TB)	Total borrowings (TB)	Asset to off balance sheet activities ratio (AOBSR)

Technicalities of DEA are quite commonplace and discussion of that is not explicitly presented here. Interested reader can collect that discussion from any textbook on DEA like Norman and Stoker (1991), Cooper, Seiford and Kaoru (2000) etc. Here we have used constant return to scale, input oriented, radial technology. All firms of data set are used to construct efficient envelope. Super efficiency is omitted so maximum possible efficiency score is technically limited to 1.00.

5. Data

We included 42 banks in our data set. We left Specialized Banks (SB) from our sample as they are established and maintained to support certain sector. So profit maximizing consideration may not be expected from their behavior. Some (not all) foreign banks are also left out from the sample as they do not enter into main stream banking and primarily facilitate local transactions with their parent country. They are left in the ground of not involving in the mainstream banking business. Out of 42 banks considered, 4 are Nationalized Commercial Banks (NCB), 30 are Private Commercial Banks (PCB) and 8 are Foreign Commercial Banks (FCB).

All data were collected from different departments of Bangladesh Bank under the restriction of not disclosing firm's identity in our result. Stock variable figures were for 31st December 2008. Flow variables were for the calendar year between 1st January 2008 and 31st December 2008. All figures are in crore taka, descriptive statistics of key variables are presented in appendix A.

6. Results

Results obtained are compiled in table 3. After running DEA model we found 6 banks to achieve a score of 100% in the first stage and 7 banks in the second stage. Only one firm scored 100% in both stages and thus can be considered as the most efficient bank in Bangladesh based on this stylized criteria. The most efficient bank belongs to foreign bank class. Standard deviations of all banks are 3.5% and 20.2% in stage 1 and stage 2 respectively. This indicates that banks are more homogeneous in intermediation operation but less in technical operation.

Among nationalized banks the maximum composite efficiency found is 55.6% and for private commercial banks the maximum composite efficiency is 95.4%. This is a sign for significant improvement in operation in favor of private banks. Disproportionately many foreign banks achieved full efficiency in stage 2. We fixed inputs and outputs of the second stage to test the technical soundness of the institution. Foreign banks are more efficient in this stage as they are more conservative in their loan selection. They can afford to do that as they do not have any implicit obligation to spread the banking service among mass population. But nationalized banks (and to some extent PCBs) have an implicit goal to extend banking service throughout the country and in that process they have to support some not so profitable branches as well as finance some not so profitable projects and thus their income potential suffers. However it should be mentioned here that issue of politically connected loan is not insignificant in Bangladesh. Those loans in many cases end up being delinquent.

But nationalized banks score very high in first stage which is an indication of their intermediation skill. They have an average efficiency score of 90.4% compared to 71.1% and 72.1% of private and foreign banks respectively. This however, is not entirely due to their skill. As nationalized banks are government backed so it enjoys full confidence of general people. People of all income groups keep deposits in nationalized banks without fearing of a bank run. This is also enhanced by the fact that private and foreign banks in many cases show their preference for relatively wealthy customers and explicitly and implicitly show reluctance to serve relatively poor people. So for financially weaker section of the society almost the only option for banking is the nationalized banks.

Table 3: Distribution of efficiency scores

Group	Stage 1	Stage 2	Stage 1	Stage 1	Stage 2	Stage 2	Comp	Comp
	100% score	100% score	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
All banks	6	7	0.7317	0.0350	0.6328	0.2021	0.4541	0.1739
NCBs	0	0	0.9041	0.174	0.4059	0.176	0.3636	0.161
PCBs	4	2	0.7115	0.189	0.6008	0.194	0.4229	0.196
FCBs	2	5	0.7215	0.175	0.8663	0.218	0.6164	0.183

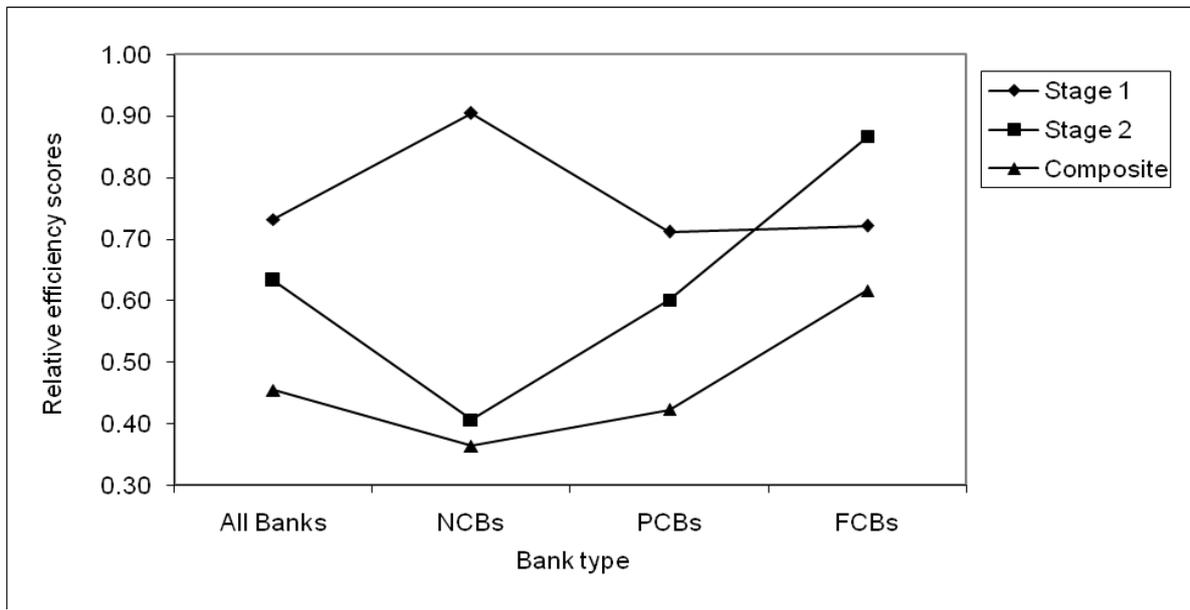
Product of efficiency scores of stage 1 and 2 are given in the composite column. Detailed histogram and measures of central tendencies of stage 1, stage 2 and composite scores are presented in Appendix B.

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We can conclude few important trends from these results. The results show that banks are more homogenous in intermediation. Nationalized banks have a clear advantage in intermediation but private and foreign banks are more or less comparable in their action. However in the second stage, which tests technical expertise banks have more dispersed in their efficiency measures.

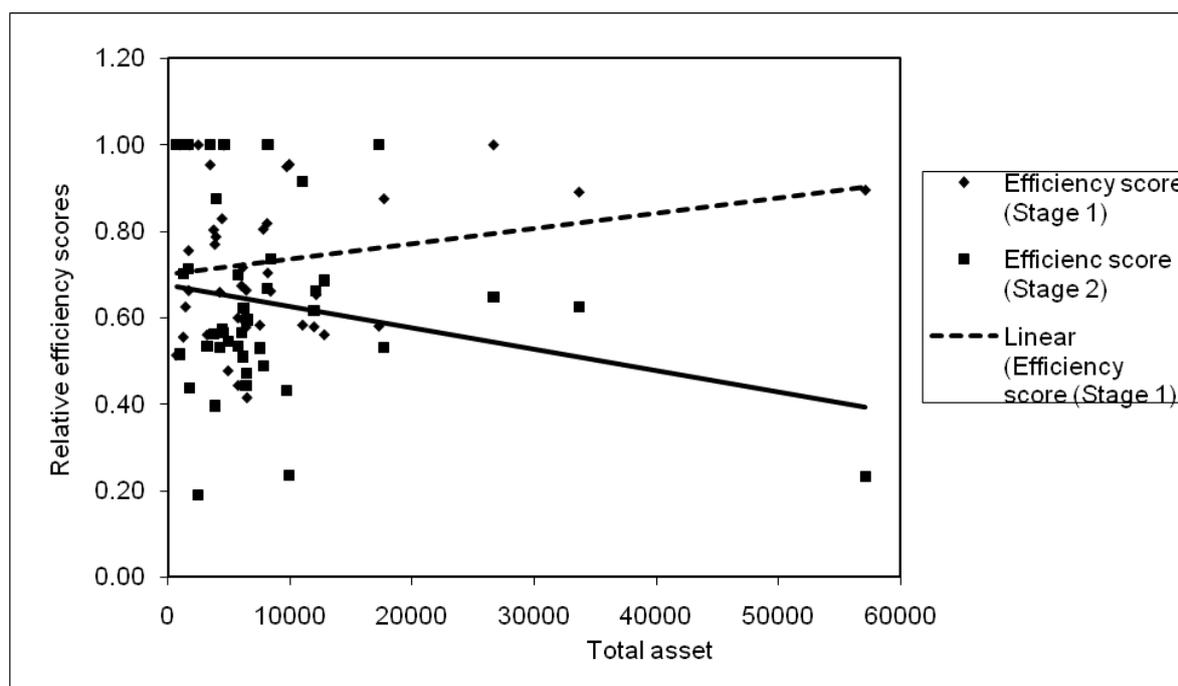
The correlation coefficient between efficiency scores of first and second stages gives a negative figure. This is uncomfortable in the sense that it would be nicer if we could have higher efficiency in both measures simultaneously for certain class of banks.

Figure 2: Relative efficiency score according to bank types



We arranged efficiency scores according to asset size in the following figure. Efficiency of stage 1 increases with asset size. This is expected as the institution gets bigger and bigger it can provide more and more services to its clientele which in return increases their efficiency. But in second stage we find that efficiency decreases with increase of asset size. This only indicates that as size of the firm goes up it becomes increasingly difficult for it to manage its operation profitably.

Figure 3: Total Asset vs. Relative efficiency score



7. Conclusion

Efficiency scores of banking companies sometimes are not well treated by the professionals as they argue that banking is a multi stage operation and a scalar efficiency score is insufficient to capture the totality of its operation. Two stage DEA can be an answer of their dissatisfaction.

Two stage DEA gives us the flexibility to use deposit and loans as inputs as well as outputs. This implicitly makes them intermediate outputs. Applying this methodology we found here that foreign banks have best overall performance. However for intermediation nationalized banks have superiority. But technical consideration makes foreign banks better off. Private Commercial Banks stay somewhere in between. We have also found that as the bank grows larger and larger it becomes less and less efficient in technical part however increasing size is intermediation enhancing. Apart from this, we found that there are ample scopes for efficiency improvement for commercial banks and further investigation can be done to identify their source of inefficiency.

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Appendix A

Table: Descriptive statistics of variables used

Class code	Statistics	OE	TC	IE	TD	TL	TB	NP	NCL	AOBSR
All Banks	Mean	142.65	507.81	357.04	5280.95	4609.93	108.91	151.31	0.9225	2387.00
NCBs	Mean	404.12	800.87	790.38	17714.35	12544.60	5.82	349.41	0.75	5.50
PCBs	Mean	125.86	471.29	360.86	4398.73	4280.69	146.67	134.17	0.93	6.56
FCBs	Mean	74.89	498.23	126.06	2372.58	1877.24	18.86	116.55	0.98	12504.39
All Banks	Standard Deviation	132.17	492.96	281.94	5708.69	4372.65	199.80	135.54	0.14	15429.38
NCBs	Standard Deviation	203.79	1251.55	480.02	9599.49	7074.02	6.44	218.78	0.10	2.47
PCBs	Standard Deviation	80.79	343.76	213.90	3209.02	3143.25	226.21	93.86	0.15	7.25
FCBs	Standard Deviation	109.35	455.58	94.69	2717.44	2153.00	18.56	159.79	0.01	35353.57
All Banks	Maximum	649.45	2190.98	1396.56	29478.76	21685.90	1129.08	594.59	1.00	100000.00
NCBs	Maximum	649.45	2190.98	1396.56	29478.76	21685.90	14.56	594.59	0.89	8.99
PCBs	Maximum	345.81	1874.24	1169.32	19176.47	18886.63	1129.08	493.13	1.00	31.95
FCBs	Maximum	331.62	1378.87	301.61	8266.55	6623.66	50.00	457.36	1.00	100000.00
All Banks	Minimum	6.65	-848.42	4.65	310.89	331.32	0.00	2.93	0.19	1.97
NCBs	Minimum	165.21	-848.42	308.05	6869.48	4725.54	0.59	62.97	0.67	3.17
PCBs	Minimum	18.27	-298.16	4.65	607.59	562.59	0.00	2.93	0.19	2.58
FCBs	Minimum	6.65	167.56	25.69	310.89	331.32	0.00	8.43	0.97	1.97

Appendix B^{iv}

Figure B1: Frequency distribution of stage 1 efficiency scores

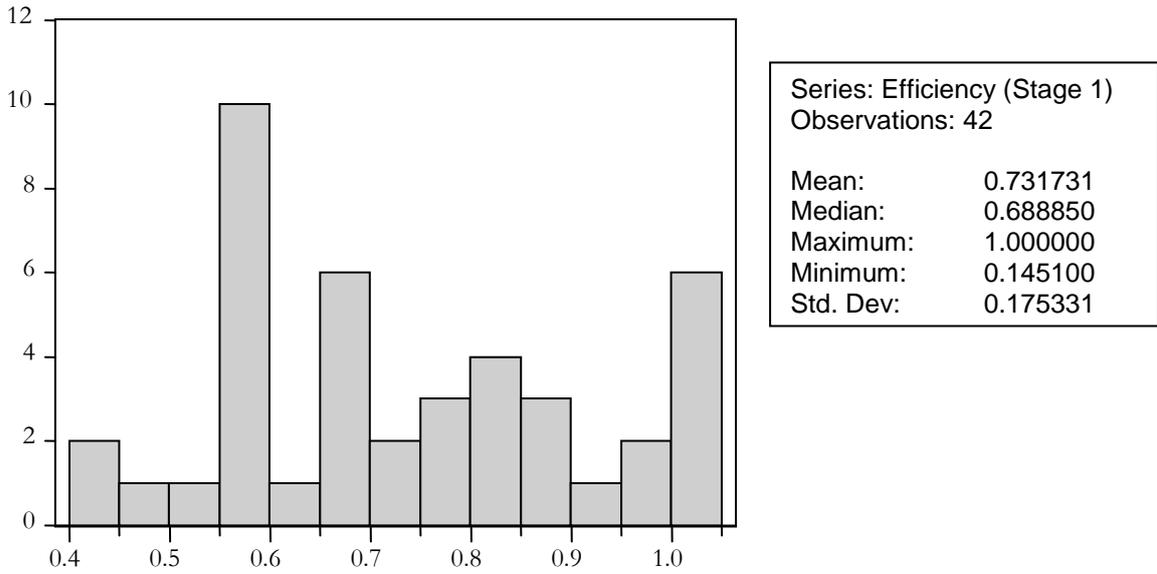


Figure B2: Frequency distribution of stage 2 efficiency scores

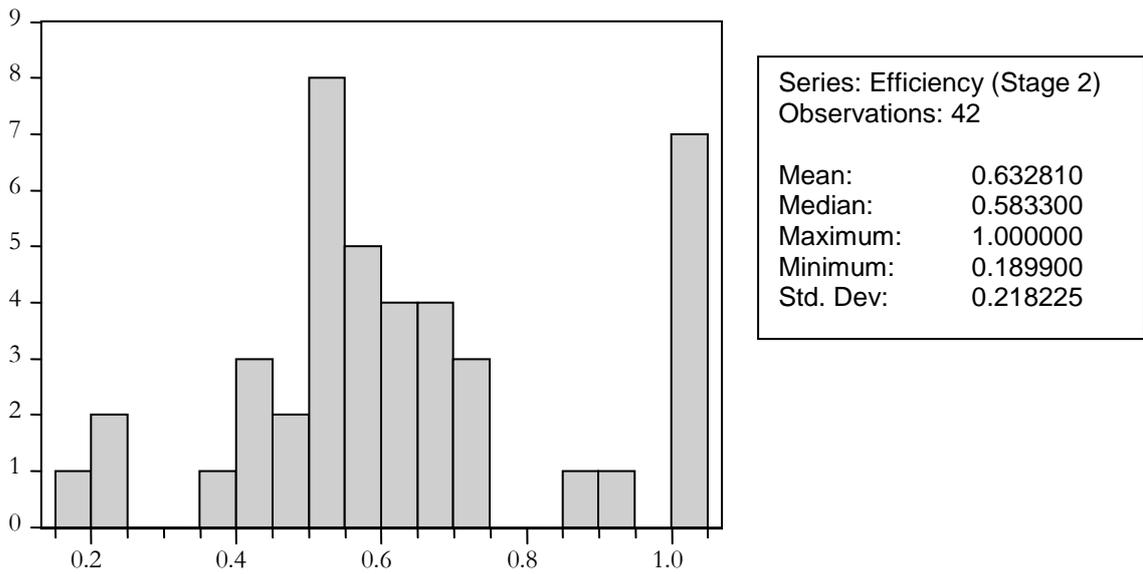
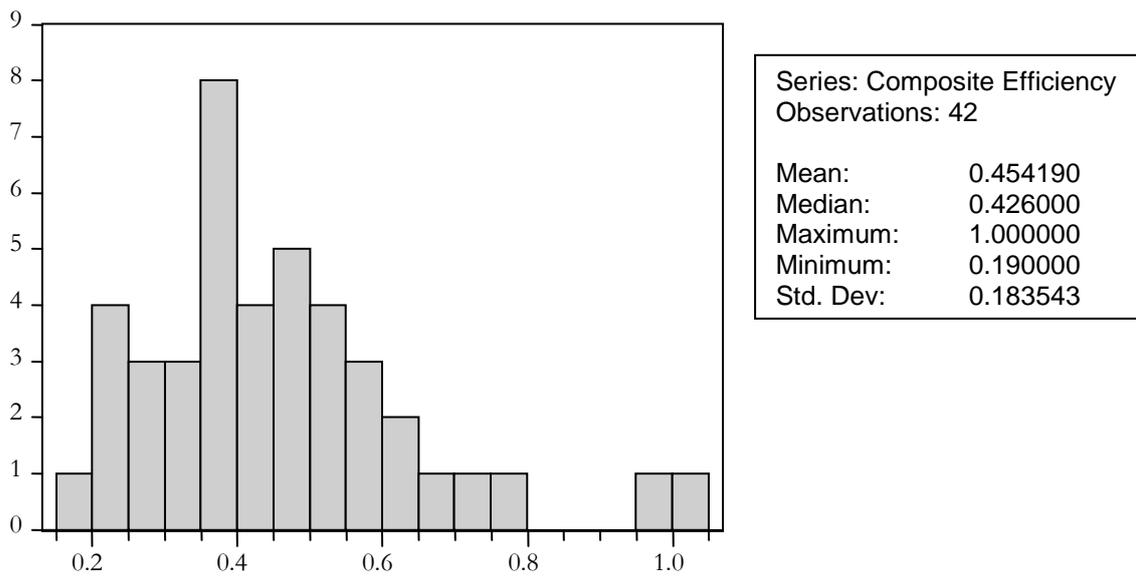


Figure B3: Frequency distribution of composite efficiency scores



Endnotes

ⁱ Return on asset

ⁱⁱ Non performing loan ratio as a percentage of total loan

ⁱⁱⁱ Technicalities of these methods are quite commonplace and a discussion can be found in Chowdhury and Rahman (2011)

^{iv} Histograms of different asset classes are available upon request