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Comparative efficiency measurement of Islamic banks and conventional banks: A DEA approach

Md. Nazmul Islam, Tanmay Biswas*, Md. Al-Amin
Department of Business Administration, Mawlana Bhashani Science and Technology University, Sontosh, Tangail, Bangladesh

Abstract
Banks play a significant role in the economic development of a country. This study attempts to evaluate operational efficiency and effectiveness, covering 12 commercial banks in Bangladesh during 2009-2015, using multiple output and input variables by applying non parametric (DEA) techniques and parametric statistical tools. The study found that the technical efficiency under CRS approach was 1.00 for the DMU AABL, and BBL. The average efficiency score was 98 percentages and the lowest score possessed by ABBL. Average technical efficiency both for Islamic banks and conventional banks were 98 percentages under CRS approach. Under the VRS approach, 9 banks were able to obtain maximum efficiency score 1.00 and the rest 3 banks scored under maximum efficiency score. Islamic banks possessed about 100 percentage efficiency while conventional banks were 99 percentages under VRS approach. In case of scale efficiency, only two banks had the efficiency score 1.00 while rest 10 banks got the score under efficiency level. The calculated result also found that there was no significance difference between the Islamic and conventional banks regarding the efficiency scores obtained by DEA. And there was positive correlation of each of the partial productivity of inputs with efficiency scores obtained by DEA. The study suggests that the inefficient banks should improve loan recovery strategies and reduce their annual expenditures within reasonable extent. Finally, some suggestions & recommendations have been provided to run the banking industry with efficient and effective operations that ensure the sector with sound position.

Keywords: banks, DEA, technical efficiency, scale efficiency, CRS, VRS

1. Introduction
Bangladesh got independence from West Pakistan after a liberation war 1971. After the independence, Bangladesh has got an experience of radical change in her every sector. Especially the economic sector is prominent. The life standard of a citizen largely depends on his /her per capita income. In this case bank plays a crucial role. After the impendence in 1971 the banking sector of Bangladesh started its journey with a new dream and new commitment towards equity and social justice along with growth and development. The newly independent government immediately designated the Dhaka branch of the State Bank of Pakistan as the central bank and renamed it as Bangladesh Bank. The Bangladesh government initially nationalized the entire domestic banking system and proceeded to reorganize and rename the various banks. Foreign-owned banks were permitted to continue doing business in Bangladesh. The new banking system succeeded in establishing reasonably efficient procedures for managing credit and foreign exchange. After the independence, banking industry in Bangladesh started its journey with 6 nationalized commercial banks, 2 State owned specialized banks and 3 Foreign Banks. In the 1980's, banking industry achieved significant expansion with the entrance of private banks. Now, banks in Bangladesh are primarily of two types: Scheduled Banks: The banks which get license to operate under Bank Company Act, 1991 (Amended in 2003) are termed as Scheduled Banks. Non-Scheduled Banks: The banks which are established for special and definite objective and operate under the acts that are enacted for meeting up those objectives, are termed as Non-Scheduled Banks. These banks cannot perform all functions of scheduled banks. There are 59 scheduled banks in Bangladesh who operate under full control and supervision of Bangladesh Bank which is empowered to do so through Bangladesh Bank Order, 1972 and Bank Company Act, 1991. In Bangladesh, currently 59 scheduled and 5 nonscheduled banks are operating their functions for strengthening the economy. Among these there are 54 commercial banks in which 6 are National Commercial Banks and 9 foreign commercial banks, 31 local conventional private commercial banks and 8 Islamic Sariah based commercial banks and 9 foreign commercial banks (*Bangladesh bank, 2016).* Islamic banking is a banking system that is based on the principles of Islamic law, also referred to as Shariah law, and guided by Islamic economics. Two basic principles behind Islamic banking are the sharing of profit and loss and, significantly, the prohibition of the collection and payment of interest by lenders and investors. Collecting interest or "riba" is not permitted under Islamic law. In order to earn money without charging interest, Islamic banks use equity-participation systems. This means that if bank loans money to a business, the business pays back the loan without interest, but it gives the bank a share in its profits. If the business defaults on the loan or does not earn any profits, the bank does not receive any profit either. For example, in 1963; Egyptians formed an Islamic bank in Mit Ghmar. When the bank loaned money to businesses, it did so on a profit-sharing model. To reduce risk, the bank only approved about 40% of its business loan applications, but the default ratio was zero. (http://

www.investopedia.com) Islamic banking and finance is a creation of modern age. Capitalism argues, capital- one of the key factors of production, deserves fixed return whereas the entrepreneurs have to bear all the risks. The conflict of opinions with the Islamic values starts from this very basic point. As the conventional banking systems follow to work smoothly in modern time without a robust banking system. (haque & Tariq, 2012) [16]. Effectiveness and efficiency are exclusive performance measures; which entities can use to assess their performance. Efficiency is oriented towards successful input transformation into outputs, where effectiveness measures how outputs interact with the economic and social environment. The assessment of the organizational philosophy of capitalism and interest which is forbidden according to Islamic Sharia, the Muslims made the first move toward the Islamic financial system was observed in the second half of 20th century when the Muslim world got liberation from colonial powers (Hanif, 2011). Conference of Foreign Ministers of Muslim countries (1973) can be marked as a landmark of the growth and popularity of Islamic Financial Institutions (IFIs). Soon after this conference, Bangladesh signed the Charter of Islamic Development Bank in August 1974. Analyzing the demand and feasibility of Islamic banking, Islamic Bank Bangladesh Limited, the first Islamic bank of Bangladesh was established in March 1983. Currently eight Sharia based Islamic banks are operating in Bangladesh with their significant contributions to the banking industry and to the financial system of the country as well. (Yousuf, Islam, & Islam, 2014 (march) As at the end of June 2016, 8 full-fledged Islamic banks are operating with 998 branches out of total 9453 branches of the banking industry; in addition, 21 Islamic banking branches of 9 conventional commercial banks and 25 Islamic banking windows of 7 conventional commercial banks are also providing Islamic financial services in Bangladesh. At the end of April-June 2016 quarter, deposits, investments and the surplus liquidity of Islamic banking industry grew by 5.73%, 4.84% and 5.84% respectively while investment deposit ratio declined by 0.84% compared to the previous quarter. Islamic Banking Industry accounted for more than one-fifth share of the entire banking industry in terms of deposits and investments at the end of the quarter under review. (Akhtaruzzaman, Awwal sarker, Moula, & Mily, 2016) [2] Banks are financial institutions engaged in boosting national savings and capital formation as well as constituting infrastructure through the financing of various developments projects. It performs multi-dimensional activities like borrowing and lending money, drawing, collecting and discounting of bills, transferring funds, safe-deposit, vault / locker service, foreign exchange transactions etc. The world of banking is undergoing a transformation. Banking today has evolved into a highly competitive and sophisticated business in which technology increasingly providing the edge. Today's customer wants service and information to be provided at all times and places. Banks have a pivotal role in growth and development of an economy where it ensures prudent allocation of capital resources and their efficient utilization; whereas it is implausible performance helps companies to improve their reports, assures smoother competition in the global market and creates a sustainable competitive advantage. Today's organizations face unprecedented challenges assessing their performance. Globalization, requirement for social responsibility, innovative technology and new strategic thinking are just a few of the aspects required in nowadays competitive economy. (Bartuševičienė, 2013) [7, 9]. Effectiveness is the extent to which planned outcomes, goals, or objectives are achieved as a result of an activity, strategy, intervention or initiative intended to achieve the desired effect, under ordinary circumstances. Example: A vaccine is effective when it is capable to produce the desired effect (protection against disease) in the population, under ordinary circumstances. Being effective means achieving organizational goals. Being efficient means achieving goals with little wasted resources. Effectiveness comes first. Efficiency is the ratio of the output to the inputs of any system. An efficient system or person is one who achieves higher levels of performance (outcome, output) relative to the inputs (resources, time, money) consumed. Examples: Worker A moved 16 boxes from the truck to the store in one hour and worker B moved 9 boxes in one hour. Worker A is more efficient than worker B. Car T uses 10 gallons to travel 150 miles, car F uses 13 gallons to travel 150 miles. Car T is more fuel efficient than car F. Efficacy is the extent to which a specific intervention, procedure, or service produces the desired effect, under ideal conditions (controlled environment, lab circumstances, yet, its effectiveness needs to be shown. Efficiency and effectiveness are both commonly used management terms. Yet, while they sound similar and start with the same letters, they both mean different things. Efficiency refers to doing things in a right manner. Scientifically, it is defined as the output to input ratio and focuses on getting the maximum output with minimum resources. Effectiveness, on the other hand, refers to doing the right things. It constantly measures if the actual output meets the desired output. Since efficiency is all about focusing on the process, importance is given to the 'means' of doing things whereas effectiveness focuses on achieving the 'end' goal. Efficiency is concerned with the present state or the 'status quo'. Thinking about the future and adding or eliminating any resources might disturb the current state of efficiency. Effectiveness, on the other hand, believes in meeting the end goal and therefore takes into consideration any variables that may change in the future. In order to be efficient time and again, discipline and rigor is required. This can build inflexibility into the system. Effectiveness, on the other hand, keeps the long term strategy in mind and is thus more adaptable to the changing environment. Since efficiency is about doing things right, it demands documentation and repetition of the same steps. Doing the same thing again and again in the same manner will certainly discourage innovation. On the other hand, effectiveness encourages innovation as it demands people to think, the different ways they can meet the desired goal. Efficiency will look at avoiding mistakes or errors whereas effectiveness is about gaining success. In the earlier days of mass production, efficiency was the most important performance indicator for any organization. However, with consumers facing an increasing number of choices, effectiveness of an organization is always questioned. In order to be a successful organization, there needs to be a balance between effectiveness and efficiency. Only being efficient and not meeting the requirements of the stakeholders

of the organization is of little use to anybody. And effectiveness may result in success but at what cost? Efficiency and effectiveness can be considered as key elements for achieving greater business performance and a better decision making. (Lu & Hung, 2011) [21]. in recent time, several new commercial banks to be have entered in the market which creates a strong competition among the commercial banks in Bangladesh. The competition among the banks has increased mainly due to market liberation, technological developments and the entrance of non-banking institutions. (Staikouras & steliarou, 1999) [10]. for this reason, the entire stakeholder is concerned with the efficiency and effectiveness of the operations of a bank. So the main purpose of this study is to measure the efficiency and effectiveness of the Islamic and conventional commercial banks of Bangladesh for the period of 2009-2015 by applying the Data Envelopment Analysis (nonparametric) approach and other statistical parametric approaches. The study also evaluates the relationship between efficiency scores calculated by DEA and partial productivity among the selected banks competing in the banking industry in Bangladesh. The structure of the study is designed as follow: In the next section literature review of previous same studies are presented, objectives and hypothesis are developed. After the methodology and suggested DEA approached are described. Then the next section is analyzing results and discussion. Finally, the last section is analyzing results and discussion. Finally, the last section represents the conclusions, references, acronyms and appendix.

2. Literature Review

The measurement of effectiveness and efficiency is a control mechanism for bank performance measurement. It has got more attention in the developed countries. It is not so popular in developed countries especially in Bangladesh. Especially the DEA (Data Envelopment Analysis) method is not popular in our country. Some prior studies relating to the measurement of efficiency and effectiveness by DEA are stated below:

Efficiency is measured through frontier non parametric technique of data envelopment analysis based on intermediation approach. During the sample period the banking sector was less efficient in the year 2009 and the projected efficiency scores recommended that Islamic banks performed more efficiently during the study period as compared to Conventional banks.(HAQUE & Tariq, 2012) [16]

In the study an attempt has been made to provide rank some of the Bangladeshi Banks. Data envelopment analysis is used for this purpose. In Data Envelopment Analysis two types measurement techniques are used-One is constant return to scale and variable returns to scale. The most efficient bank is identified here by the highest efficiency score obtained from the sample banks. (Hoque & Rayhan, 2013 (January) [17].

A study has been done for finding out the efficiency of Indians banks with the help of Data Envelopment Analysis method in terms of gaining confidence from investor s and ranking them accordingly. The study suggests that private sector banks are most advantageous situation and thereby hinting at the possibility of further improvisations of most of the public sector banks. Also the private sector banks show marked consistency in their efficiency level during the period under study. (Agarwal, Guha, Dutta, & Bandypadhyay, 2014 (January) [1].

Performance is measured assuming a black -box production structure and then the black-box is opened and examined using a two stage network production structure. Currently period performance in maximizing desirable loans and securities investments and maximizing bad loans depends on how efficiently inputs at one stage of production are transformed into intermediate outputs which are used at a subsequent stage of production. (Akther, Fukuyama, & Weber, 2013) [3].

Yannick, Honghong, & Thirry, (2016) [32] used Data Envelopment Analysis for efficiency measurement of Co'te d'Ivorian banks. They suggested that private banks are relatively more efficient than public ownership ones.

Uddin & Bristy, (2014) [30] made an study and found that all of the selected banks are in a position to make a sustainable growth in respect of branches, employees, deposits, loans and advances, clssified loans, net income and earnings per share during the period of 2007-2011 with some fluctuation. They also said that the value of the slope always showed the positiove number, it was a clear indication that Bangladesh has a very good prospect in case of private commercial banks.

Ar & Kurtaran, (2013) [5] measured the relative efficiency of 13 commercial banks in Yurkey for the year of 2011 with an integrated approach which included analytic Hierarchy process and Data Envelopment Analysis. They used two inputs like personal expenditures and number of branch and four outputs like deposits, national currency, deposists-foreighn currency and precious metal, cash loans and non-cash loansinterms of production approach. They found that foreign owned commercial banks had the lower efficiency scores than both state owned and private owned commercial banks. They also suggested that inefficient banks should improve their non-cash loans and should focus on their annual personal expenditure.

E. Halkos & Salsmouris, (2004) [12] made an study which offered an application of a non-parametric analytic technique (data envelopment analysis, DEA) in measuring the performance of the Greek banking sector. It was shown that data envelopment analysis could be used as either an alternative or complement to ratio analysis for the evaluation of an organizations performance. They found that higher the size of the total assets, higher the efficiency.

Chansarn, (2008) [11] made an study to examine the relative efficiency of Thai commercial banks during 2003-2006 by utilizing Data Envelopment Analysis. It was made on the basis of 13 commercial banks. He found that small banks were the most efficient banks via intermediation approach. He also found that incumbent in average, were more efficient than new entries in perspective of intermediation approach.

Yu, Barros, Yeh, Lu, & Tsai, (2012 (July) [34] investigated the efficiency and the determinants of efficiency of optoelectronic firms in Taiwan. The investigation was done by Data Envelopment Analysis Approach which found that the profitable firms were more likely to operate at higher levels of efficiency. They also found that firm's size has a positive impact on efficiency, but its effect was statistically insignificant. Also another findings recommended that the size of employees has a statisticaly insignificant adverse influence on the performance. That means it indicated that the increase size of employees may had increased the cost and affects

efficiency negatively.

Wanke, Barros, & Joao Macanda, 2015) [31] made an efficiencyassesment of the Angolan banks using Technique for Order Preference by Similarity to Ideal solution whics is related to the DEA approach. It was found that variable related to cost structure had a prominent negative impact on efficiency. It also indicated that the Angolan banking market would benefit from higher level of competition between instititions.

A case study supported the ideas that rating formats needed reexamination with a focus on compuiter based models as an alternative to traditional rating methods. It was also found that DEA could overcome the shortfalls of previous methods. (Research and practice in human Resource Management, (2009) [26].

A study was made to catch the nature of the disclosure of effectiveness, efficiency and quality in the widwer context of prevailing ideas about the role of government in the promotion of welfare services. The study offered three descriptions of efforts for developing the measurement systems in the public sector organizations. (Measurement of Effectiveness, Efficiency and Quality in public Service-Interventionist Empirical Investigations, 23-26 November 2011).

Amirteimoori & Kordrostami, (2010) [4] made an study and it was proven that DEA models not only measure the efficiency acroos all periods, but also they provide the efficiency measures for each of the periods.

Koclsova, (2014) [19] made an study applying DEA to a sample Slovak and Czech commercial banks during the study period 2009-2013 comparing the efficiencies by either minimizing cost or maximizing revenue and profit.The result suggested that the average revenue efficiency was the highest and the average profit efficiency was the lowest one.

Bartuševičienė & Šakalytė, (2013) [7, 9] made an study and found that effectiveness and efficiency were exclusive performance measures; which entities could use to assess their performance. Efficiency is oriented towards successful input transformation into outputs, where effectiveness measures how outputs interact with the economic and social environment.

Zere, *et al*., 2007 [35] (27 march) used the DEA approach and the findings suggested the presence of substantial degree of pure technical and scale inefficiency. The average technical efficiency level during the given period was less than 75%. Less than half of the hospitals included in the study were located on the technically efficient frontier. Increasing returns to scale was observed to be the predominant form of scale inefficiency.

Hoque & Israt Rayhan, 2013 (Januar) [17] made an study and they tried to rank some of the banks of Bangladesh by using the DEA approach. The most efficient bank was identified by the highest efficiency score.

Roghaniana, Raslia,, & Hamed Gheysaria, (2012) [27] made an study by reviewing the definition of efficiency, effectiveness and the necessity of paying attention to both side of productivity.This paper suggested that literature suggested to banks managers and policy makers to evaluate their productivity and also their productivity positions accurately based on effectiveness and efficiency.

Lu & -Hung, (2011) [21] made an study on 30 global retailing industris on the basis of efficiency and effectiveness. It was done by DEA approach combining multiple outputs and inputs to explore the efficiency. The result suggested that the overal technical inefficiency of the companies were primarily due to scale inefficiency rather than pure technical inefficiencies. Yhe result also suggested that about 57% of the global retailing companies were regarded as efficient. About 43 % of the companier required to reduce their inputsif they were to be efficient.

Bartuševičienė & Šakalytė (2013) [7, 9] found that effectiveness and efficiency were exclusive performance measures, which entities could use to assess their performance. Efficiency was oriented towards successful input transformation into outputs, where effectiveness measures how outputs interacted with the economic and social environment.

Mikusova, (2015) [25] made an study on the public universities of Czech Republic to measure the efficiency of the universities. Here the non- parametric DEA method was used which evaluated the technical efficiency of homogenous production units. Academic staff and other costs were used as input and the bachelor and master's graduates and students, PHD graduates and st, HK u dents as output. Aziza, Janorb,, & Rasidah Mahadic, (2013) [6] used DEA approach for efficiency measuerment of Malasyan universities where the academic staff, nonacademic staff, and operating expense were taken as input variable while the output variables were number of graduates for the year, total amount of research grant received for that year and number of academic publications by faculty members. The findings revealed that the social science based departments on average performed better than the science based departments. Staat, (2006) [28] made study on German hospitals services by DEA approach. The main finding of the study was that significant productivity differences between nearly identical hospitals exist. These differences were less dramatic than some findings in other studies on German hospitals; on the other hand, the bias-corrected results imply a much larger inefficiency than the results obtained in other DEA studies with German data.

Concerning the Bangladeshi commercial (Islamic and conventional) banks, available studies were not done using data envelopment analysis approach for the measurement of efficiency. Very few studies were done on the efficiency measurement of Islamic and conventional commercial banks in Bangladesh. Considering this fact, here this study is done to measure the comparative efficiency measurement of Islamic and conventional commercial banks by data envelopment analysis approach (non-parametric) and other parametric statistical approach.

3. Objectives of the Study

The study aims to measure the efficiency of selected Islamic and conventional commercial banks. The specific objectives of the study are considered as below:

1. to know the concept of effectiveness and efficiency;
2. to make an understanding of the banking sector regarding effectiveness and efficiency during the study period;
3. to identify the input factors those are related to outputs of the selected banks;
4. to find out the causes and effect of effectiveness and efficient use of inputs to achieve better outputs during the study period; and

5. To provide suggestions and recommendations for the betterment of the banking sector in Bangladesh.

4. Hypothesis of the Study

Hypothesis 1: There is no difference between the Islamic and the Conventional banks regarding the efficiency scores obtained by DEA.

Hypothesis 2: There is no positive correlation of each of the partial productivity of inputs with efficiency scores obtained by DEA.

5. Methodology

For the study only the commercial banks have been selected. From the 54 scheduled commercial banks here only 12 banks are selected. Among the banks 6 are Islamic and 6 are conventional banks are selected for transparent comparison of data and information. The secondary data were collected from the annual report of the selected banks for the study period 2009-2015. The selection of the banks are random sampling and here both the parametric and non-parametric methods were used. The selected banks are Shahjalal Islamic Bank Ltd, Islamic Bank Bangladesh Ltd, Al-Arafa Bank Ltd, First Security Islami Bank Ltd, Social Islami Bank Ltd, Exim Bank Ltd, Prime Bank Ltd, Brac Bank Ltd, Mercantile Bank Ltd, Arab-Bangladesh Bank Ltd. Standard Bank Ltd. South –East Bank Ltd. For conducting this study here main emphasis is given on the variables Int. Income, non-interest income, investment, interest expense, loan & advanced, fixed assets, operating expense, Shareholder equity etc. Here DEA (non-parametric technique) is used to measure the technical and scale efficiency of the sample banks. Both the Input oriented CRS and VRS approach are used. Arithmetic mean, minimum, maximum, co-relation, co-efficient of variance, t- test are used for making the study easier. It is a true fact that the measurement of the input and output variable is difficult for the different nature of business.

6. Data Envelopment Analysis and Interpretation with findings

DEA was first introduced by Charness *et al* in 1978 for measuring the relative efficiency of organizations such as hospitals and schools that lack the profit maximization motive. (Zere, Mbeeli2, Mandlhate3, Mutirua, Tjivambi2, & Kapenambili, 2006) [35]

DEA is a non-parametric method in operations research and economics for the estimation of production frontiers. DEA is a mathematical programming approach which is used to construct a frontier or production possibilities curve for a set of decision making units. A linear program is applied to create a virtually efficient DMU that sits on the efficiency frontier, in which each DMU has hundred per cent efficiency in relation to every other DMU. The first constraint forces the virtual DMU to produce at least as many outputs as the studied DMU. The second constraint finds out how much less input the virtual DMU would need. Data envelopment analysis (DEA) is a non-parametric technique for measuring and evaluating the relative efficiencies of decision-making units (DMUs). Since the pioneering work of Charnes *et al.* (1978), DEA has demonstrated to be an effective technique for measuring the relative efficiency of a set of DMUs which utilize the same inputs to produce the same outputs. Standard DEA assumes that the assessed units are homogeneous and the DEA models presented are designed to obtain a single measure of efficiency for each DMU.

In DEA context, there are two types of efficiency measures: technical and overall efficiency. The technical efficiency measures the DMU's success in producing maximum outputs from a given set of inputs. On the other hand, the overall efficiency or price efficiency measures the DMU's success in choosing an optimal set of inputs with a given set of input prices. In the real world, there are cases that a DMU's production activity is examined in the course of *T* periods, and the periods are interdependent in the sense that some outputs at one period can be inputs to later stage of production. DEA measures efficiency by estimating an empirical production function, which represents the highest values of outputs that could be generated by relevant inputs, as obtained from observed and input output factors for the analyzed Decision Making Units (DMU). The efficiency of a DMU is then measured by the distance from the point representing its input and output values to the corresponding reference point on the production function. (Manoharan, Muralidharan, & Deshmukh, 2009) [23]. According to the DEA method a decision making units will be called efficient when its optimal value is equal to 1 and the inefficient units have a value less than 1. In this study the input oriented approach is applied where the decision making unit tries to produce more output by consuming less input.

Table 1: Descriptive Statistics of Selected Outputs and Inputs Variable of sample Banks (DMUs) Tk (in millions)

Particulars	Outputs		Inputs					
	X1	X2	Y1	Y2	Y3	Y4	Y5	Y6
Average	4554.84	4054.74	20855.88	11012.54	124403.18	3631.91	3924.85	16602.89
Max.	15011.00	8224.47	47170.43	23146.46	349069.37	11814.55	9071.67	44487.74
Min.	1912.70	721.17	4775.43	6335.87	64602.69	1308.14	1547.30	5992.41
C.V	77.988	61.684	76.928	40.901	60.057	81.254	64.794	70.878

***Source*:** Annual reports covering the periods2009-2015, the number of banks, N=12

The table shows the descriptive statistics of input and output variables of the selected sample banks for the year 2009-2015.Here the output variables are Interest /investment income (X1), and Non-interest income(X2). The input variables are Investment (Y1) Interest Expenses (Y2), Loan and Advanced (Y3), Fixed Assets (Y4), Operating Expenses (Y5) and the Shareholder Equity (Y6). The average, the maximum level (Max.), the minimum level (Min.) and co-efficient of variation (C.V) of the selected input variables and output variables have been shown in the above mentioned table no.1.

Table 2: Correlation co efficient among the output and input variables

Variables	Output variables		Input variables					
	X1	X2	*Y1*	*Y2*	*Y3*	*Y4*	*Y5*	*Y6*
Interest Income(X1)	1							
Noninterest Income(X2)	.402	1						
Investment(Y1)	.431	0.927**	1					
Interest expense(Y2)	0.795**	0.651 *	0.786**	1				
Loan& advanced(Y3)	0.927**	0.542	0.658 *	0.956**	1			
Fixed Assets(Y4)	0.795**	0.684*	0.803**	0.931**	0.931**	1		
0perating expense (Y5)	0.690 *	0.845**	0.802**	0.780**	0.750**	0.859**	1	
Shareholder Equity(Y6)	0.433	0.712**	0.785**	0.712**	0.629*	0.818**	0.825**	1

***Source*:** Calculated from annual reports during the periods 2009-2015, the number of banks, N=12

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

The above table shows the correlation coefficient among the output and input variables. In the table it is seen that the output variable Interest income (X1) has significant correlation with input variables Interest Expense (Y2), Loan &Advanced (Y3), Fixed Assets (Y4) at the 1% level and with Operating Expense at the 5% level. Interest Income has also insignificant correlation with non-interest Income(X2), Investment (Y1), and Shareholder Equity (Y6). On the other hand, the output variable non-interest income (X2) has significant correlation with input variables Investment (Y1), Operating Expense (Y5), Shareholder Equity (Y6) at the 1% level and with Interest Expense (Y2), and Fixed Assets (Y4) at the 5% level. It has also significant correlation with input variable loan & Advanced (Y3). The input variable Investment (Y1) has significant correlation with input variables Interest Expense (Y2), Fixed Assets (Y4), Operating Expense (Y5), Shareholder equity (Y6) at the 1% level and with Loan & Advanced (Y3) at the 5% level. Similarly, the input variable Interest Expense (Y2) has significant correlation with the input variables Loan &Advanced (Y3), Fixed Assets (Y4), Operating Expense (Y5), and Shareholder equity at the 1% level. In the same way the input variable Loan & Advanced has significant correlation with the input variables Fixed Assets (Y4), Operating Expense (Y5) at the 1% level and with Shareholder Equity at the 5% level. Again, the table shows that the input variable Fixed Assets (Y4) has significant correlation with the input variable Operating Expense (Y5), Shareholder equity (Y6) at the 1% level. The table also depicts that the input variable Operating expense (Y5) has significant correlation with the input variable Shareholder Equity at the 1% level

Empirical Analysis and Results Table: 3

Table 3: Technical efficiency under Input oriented CRS Approach

Bank	2009	2010	2011	2012	2013	2014	2015	Mean	Max.		Min.	CV	Total peers	Rank
									Score	Time				
SHIBL	0.968	1	1	1	.92	.91	0.82	0.95	1	3	0.82	7.1	1	5
ISBL	1	1	1	1	1	1	.92	0.99	1	6	0.92	3.06	5	2(5)
AABL	1	1	1	1	1	1	1	1	1	7	1	0	12	1(12)
FSIBL	1	0.98	.99	1	1	1	1	0.99	1	5	0.98	.69	0	2(0)
SIBL	1	0.90	1	1	.93	1	1	0.98	1	5	0.90	4.26	5	3(5)
EXBL	1	1	1	1	1	.90	.94	0.98	1	5	0.90	4.25	7	3(7)
PBL	1	0.95	1	1	.996	1	1	0.99	1	5	0.95	1.78	3	2(3)
BBL	1	1	1	1	1	1	1	1	1	7	1	0	21	1(21)
MBL	1	0.98	1	1	1	1	1	0.99	1	6	0.98	.91	8	2(8)
ABBL	.931	0.82	.96	1	.90	1	.91	0.93	1	2	0.82	6.73	1	6
STBL	1	1	1	1	1	1	.92	.99	1	6	0.92	3.14	2	2(2)
SEBL	1	1	1	1	.85	.942	1	0.97	1	5	0.85	5.98	7	4
Mean	0.99	0.97	0.99	1	0.97	0.98	0.96							
Max. Score	1	1	1	1	1	1	1							
Max. Time	10	7	10	12	7	9	7							
Min. Score	0.93	.82	0.96	1	.85	.90	.82							
SD	.02	.05	.01	0	.05	.04	.06							
CV	2.14	5.62	1.16	0	5.48	4.08	6.03							

***Source*:** Computed from original data of banks annual reports during the study period 2009-2015. N=12.

Technical efficiency is the effectiveness with which a given set of inputs is used to produce an output. A firm is said to be technically efficient if a firm is producing the maximum output from the minimum quantity of inputs, such as labor, capital and technology. For example, a firm would be technically inefficient if a firm employed too many workers

than was necessary or used outdated capital. The concept of technical efficiency is related to productive efficiency. Productive efficiency is concerned with producing at the lowest point on the short run average cost curve. Thus productive efficiency requires technical efficiency. The concept of technical efficiency is also related to X-inefficiency. X-inefficiency is said to occur when a firm fail to be technically efficient because of an absence of competitive pressures. E.g. a monopoly employs inefficient working practices because it has no incentive to cut costs. Technical efficiency is necessary for allocation efficiency to be achieved. However, allocation efficiency also requires the optimal allocation of resources.(Tejvan Pettinger November 28, 2012) [29] Situation where it is impossible for a firm to produce, with the given know how,(1) a lager output from the same inputs or (2) the same outputs with less of one or more input without increasing the amount of other inputs.

The table given above depicts the determination of technical efficiency scores of 12 banks (6are Islamic and 6 are conventional banks) which are taken as sample for the study. It gives result under DEA (input oriented constant return to scale (CRS)) approach. The input oriented measures told us the amount of input quantities can be changed rationally without changing the output quantities produced. It is found that the decision making units (DMU) AABL, BBL have efficiency score 1 for 7 times out of seven years. Similarly, decision making units ISBL, MBL, and STBL have efficiency score 1 for 6 times out of seven years. Again decision making units FSIBL, SIBL, EXBL, PBL, and SEBL have efficiency score 1 for 5 times out of seven years. In the same way the decision making units SHIBL, ABBL have efficiency score 1 for 3 and 4 times out of seven years respectively. So it is clear that the decision making units AABL, BBL have gained the maximum efficiency score (1) and the unit ABBL has gained the least efficiency score (.93). The C.V of the sample period of efficiency scores are shown highest (6.03%) in 2015 and for the unit SHIBL (7.10 %) which indicate that less uniformity to achieve desired efficiency scores of the study period and decision making units respectively. On the contrary, the least C.V efficiency scores are attained in the period 2012 (0%) and for units AABL (0%) that indicate the more consistency among the period and units respectively. Here the rank of the performance of the bank is made on the basis of average technical efficiency score. Here the number of peers count during the study period is also used to rank the banks whose average technical efficiency score are same under CRS approach. For the banks whose technical efficiency are same then the rank is made upper position whose total number of peers is more than the others. On the basis of the above criteria, the bank BBL has gained the first position. Although, the bank AABL has the same efficiency score, but it has lower total peers. So it is not placed on the first position. Similarly, the bank ABBL has gained the last ranking for its lowest efficiency score (.93).

Table 4: Technical efficiency under Input oriented VRS Approach

Bank	2009	2010	2011	2012	2013	2014	2015	Mean	Max.		Min.	C.V	Total Peers	Rank
									score	Time				
SHIBL	1	1	1	1	1	1	1	1	1	7	1	0	0	1(0)
ISBL	1	1	1	1	1	1	1	1	1	7	1	0	5	1(5)
AABL	1	1	1	1	1	1	1	1	1	7	1	0	4	1(4)
FSIBL	1	1	1	1	1	1	1	1	1	7	1	0	0	1(0)
SIBL	1	1	1	1	1	1	1	1	1	7	1	0	3	1(3)
EXBL	1	1	1	1	1	0.901	0.998	0.99	1	5	.90	3.87	2	2(2)
PBL	1	1	1	1	1	1	1	1	1	7	1	0	4	1(4)
BBL	1	1	1	1	1	1	1	1	1	7	1	0	7	1(7)
MBL	1	1	1	1	1	1	1	1	1	7	1	0	4	1(4)
ABBL	.934	0.834	0.966	1	0.96	1	0.93	0.95	1	2	.83	6.0	1	3
STBL	1	1	1	1	1	1	1	1	1	7	1	0	1	1(1)
SEBL	1	1	1	1	0.917	1	1	0.99	1	6	.92	3.17	1	2(1)
Mean	0.99	0.99	0.99	1	0.99	0.99	0.99							
Max. Score	1	1	1	1	1	1	1							
Max. Time	11	11	11	12	10	11	10							
Min. Score	0.93	0.83	0.97	1	0.92	0.90	0.93							
SD	0.02	0.05	0.009	0	0.03	0.03	0.02							
CV	1.92	4.86	0.98	0	2.74	2.88	2.09							

***Source*:** Computed from original data of banks annual reports during the study period 2009-2015. N=12

The table given above describes the technical efficiency scores of the selected banks under the DEA, input oriented variable return to scale (VRS) approach. It describes efficiency scores for the study period 2009-2015.The CRS approach is used when all the DMU are not operating at the optimal scale. On the other hand, the VRS approach is used assuming all the DMU are not operating at the optimal scale. In the table it is noticeable that the decision making units SHIBL, ISBL, AABL, FSIBL, SIBL, PBL, BBL, MBL, STBL have the efficiency score1.That means they are technically efficient for all the study years. On the other hand, the decision making unit ABBL has the technical efficiency score (.95). It is also noticeable that it has the efficiency score 1 only for two years out of seven years indicating the inefficiency in 5 years out of seven years. The fluctuating efficiency trend is also found for the unit. Again the decision making unit EXBL has average technical efficiency score.99. It has the efficiency score 1 for five years out of seven years

which indicates the unit is inefficient for 2 years like 2014(.90) and 2015(.998). Similarly, the decision making unit SEBL has the technical efficiency score is.99. It has the efficiency score 1 for six years out of seven years indicating inefficient for only one years. And the inefficient year is 2013(.917). Though the year 2013 is inefficient but the next two years is efficient. It indicates that the unit has recovered its inefficiency problem. The C.V of the decision making units SHIBL, ISBL, AABL, FSIBL, SIBL, PBL, BBL, MBL, STBL is 0% which indicates that these units are more uniform in regards of efficiency. The least C.V score 0% is found in the year 2012 which also indicates the most consistency among the periods. On the other hand, the C.V of the study periods are shown highest 6% for the decision making unit ABBL and for the study period 2010 by 4.86% indicating least consistency to capture efficiency score of the units and the period respectively. The rank is made on the basis of average technical efficiency scores and total number of peers. So the 1st and last rank goes to the decision making units BBL and ABBL respectively for their average efficiency score and the total number of peers count.

Table 5: Scale Efficiency under VRS Approach

Table No-5ank	2009	2010	2011	2012	2013	2014	2015	Mean	Max	Min.	CV
SHIBL	0.968 irs	1	1	1	0.923 irs	0.905 irs	0.821 Irs	0.945	1	.821	7.1
ISBL	1	1	1	1	1	1	.920 drs	0.989	1	0.92	3.06
AABL	1	1	1	1	1	1	1	1	1	1	0
FSIBL	1	0.982 Irs	.993Irs	1	1	1	1	0.996	1	0.982	.69
SIBL	1	0.904 Irs	1	1	.928 Irs	1	1	0.976	1	0.904	4.26
EXBL	1	1	1	1	1	.995 drs	.943 drs	0.991	1	0.943	2.15
PBL	1	0.953 drs	1	1	.996 drs	1	1	0.993	1	0.953	1.78
BBL	1	1	1	1	1	1	1	1	1	1	0
MBL	1	0.976 irs	1	1	1	1	1	0.997	1	0.976	0.91
ABBL	.997 irs	0.986 irs	.993 irs	1	.940 drs	1	.980 irs	0.98	1	0.94	2.17
STBL	1	1	1	1	1	1	.918 irs	0.988	1	0.918	3.14
SEBL	1	1	1	1	.924 drs	.942 drs	1	0.981	1	0.924	3.37
Mean	0.99	0.98	0.99	1	0.98	0.99	0.97				
Max. Score	1	1	1	1	1	1	1				
Max. Time	10	7	10	12	7	9	7				
Mini Mum	0.97	0.90	0.99	1	0.92	0.91	0.82				
SD	0.009	0.029	0.003	0	0.035	0.031	0.056				
CV	0.92	2.94	0.27	0	3.6	3.11	5.78				

The scale efficiency score indicates whether a firm operates at the most productive scale size (score=1) or not. A score smaller than one indicates the firm is over/under-dimensioned. A unit is scale efficient when its size of operations is optimal so that any modifications on its size will render the unit less efficient. Scale efficiency is calculated from the difference between the VRS technical efficiency and CRS technical efficiency. Scale efficient branch works at the most productive scale size. Scale efficiency of scale occurs when the company's produces on the lowest point of its long run average cost and therefore benefits fully from economies of scale (Sanchez, 2009). Also scale efficiency measures a company's productivity at a given point with respect to what it could accomplish if it operated at the most productive scale size, where the average productivity reach a maximum level (Kounetas and Tsekouras, 2007) [20]. The table given above depicts the scale efficiency of the selected 12 banks whose 6 are Islamic and the rest 6 are conventional. The average scale efficiency of the decision making units ISBL, BBL is the highest that is 1. That means they have efficiency score 1 for seven periods out of seven years. On the other hand, the decision making unit ABBL has failed to reach the score 1 for 5 times out of seven study periods. It also indicates that the decision making unit has gained score 2 times out of seven periods indicating lower scale efficient among the decision m Tejvan aking units. Although the average scale efficiency score is lowest for the decision making unit SHIBL (.945), it has gained the score 1 for 3 times out of seven periods. That means it has gained score 1 one time more than that of the decision making unit ABBL. The trend of scale efficiency is increasing in moderate nature during the study periods. The C.V of the sample periods are shown highest (7.1%) for the unit SHIBL and in 2015 (5.78%) indicating the least uniformity to attain the desired efficiency score of the units and periods respectively. On the other hand, the least C.V of efficiency scores is for the units AABL, BBL (0%) and for the period 2012 (0%) denoting the most consistency among the units and the periods respectively regarding efficiency scores. There is no positive correlation of each of the partial pr Tejvan oductivity of inputs with efficiency scores obtained by DEA

Table 6: Partial Productivity Test under CRS approach

	Mean technical efficiency						
	PP-Y1	PP-Y2	PP-Y3	PP-Y4	PP-Y5	PP-Y6	PP-Y1
Mean technical efficiency	1						
PP-Y1	0.001	1					

PP-Y2	0.088	0.177	1				
PP-Y3	0.077	-0.016	0.914	1			
PP-Y4	0.329	0.381	0.617	0.636	1		
PP-Y5	0.010	0.511	0.076	-0.030	0.498	1	
PP-Y6	0.265	0.256	0.733	0.667	0.711	0.208	1

***Source*:** Calculated from the partial productivity of selected variables of the banks.
Where PP=Partial Productivity

The above table describes the correlation analysis of partial productivity and efficiency scores of the selected banks under input oriented CRS approach. The output variable here is income denoted by mean technical efficiency and the input variables are Investment (PP-Y1), Interest Expenses (PP-Y2), Loan and Advanced (PP-Y3), Fixed Assets (PP-Y4), Operating Expenses (PP-Y5) and the Shareholder Equity (PP-Y6). The table shows that the output variable Income has a positive relation with all of the input variables. The highest positive relation remains with the Fixed Assets (PP-Y4) (.33) and the lowest positive relation with the input variable Investment (PP-Y5) (.001). The input variable Investment (PP-Y1) has a positive relation with all of the input variables except the Loan &Advanced (PP-Y3) (-0.016). The highest relation is found with the input variable Operating Expenses (PP-Y5) (.511) and the lowest with the input variable Loan and Advanced (PP-Y3) (-0.016). Again the input variable Interest expense (PP-Y2) has a very significant positive relation with the input variables Loan & Advanced (PP-Y3) (.914), Fixed Assets (PP-Y4) (.617), Operating Expenses (PP-Y5) (.076), and Shareholder Equity (PP-Y6) (.733). It has the highest relation with the input variable Loan & Advanced (PP-Y3) (.914) and the lowest relation with the variable Operating Expenses (.076).Similarly, the input variable Loan & Advanced (PP-Y3) has positive relation with the input variables Fixed Assets (PP-Y4) (.636), and the Shareholder Equity (PP-Y6) (.667). In the same way, it has a slight negative relation with the input variable Operating Expenses (PP-Y5) (-0.030). Furthermore, the input variable Fixed Assets (PP-Y4) has a significance positive relation with the variable Operating Expense (PP-Y5) (.498) and Shareholder Equity (PP-Y6) (.711). Again the input variable Operating expense has also a positive relation with the variable Shareholder Equity (PP-Y6) (.208). From the above discussion it is clear that most of the variables have positive relation with one another. For this reason, the hypothesis "There is no positive correlation between the input and output variables of the Islamic and Conventional banks." is rejected. And it is accepted that there is a positive correlation between the input and output variable of the Islamic and Conventional bank.

There is no positive correlation of each of the partial productivity of inputs with efficiency scores obtained by DEA

Table 7: Partial Productivity Test under VRS approach

	Mean technical efficiency	**PP-Y1**	**PP-Y2**	**PP-Y3**	**PP-Y4**	**PP-Y5**	**PP-Y6**
Mean technical efficiency	1						
PP-Y1	0.208	1					
PP-Y2	-0.017	0.177	1				
PP-Y3	-0.015	-0.016	0.914	1			
PP-Y4	0.136	0.381	0.617	0.636	1		
PP-Y5	0.080	0.511	0.076	-0.030	0.498	1	
PP-Y6	0.121	0.256	0.733	0.667	0.711	0.208	1

***Source*:** Computed from the partial productivity of selected variables of the banks.
Where PP=Partial Productivity

The above table describes the correlation analysis of partial productivity and efficiency scores of the selected banks under input oriented VRS approach. Here the output variable is Income denoted by mean technical efficiency and the input variables are Investment (PP-Y1), Interest Expense (PP-Y2), Loan & Advanced (PP-Y3), Fixed Assets (PP-Y4), Operating Expense (PP-Y5) and the Shareholder Equity (PP-Y6). From the table it is seen that the output variable Income has a positive relation with the input variables Investment (PP-Y1) (.21), Fixed Assets (PP-Y4) (.14), Operating Expense (PP-Y5) (.08) and Shareholder Equity(PP-Y6) (.12).It has also a negative relation with the input variable Interest Expense (PP-Y2) (-0.2) and Loan & Advanced (PP-Y3) (-0.01).The highest relation exists with the variable Investment (PP-Y1) (.20) and the lowest relation with the Interest Expense (PP-Y2) (-0.02).In the same way, the input variable Investment (PP-Y1) has significant positive relation with the input variable Interest Expense (PP-Y2) (.18), Fixed Assets (PP-Y4) (.38), Operating Expense (PP-Y5) (.51), and Shareholder Equity (PP-Y6) (.26). Meanwhile, it has also a negative relation with the input variable Loan & Advanced (PP-Y3) (-0.02).The highest relation exists with the input variable Operating Expense (PP-Y5) (.51) and the lowest with the variable Loan & Advanced (-0.02). Similarly the input variable Interest Expense (PP-Y2) has a positive relation with the entire input variables like Loan & Advanced (PP-Y3) (.91), Fixed Assets (PP-Y4) (.62), Operating Expense (PP-Y5) (.08), and the Shareholder Equity (PP-Y6) (.73).The highest relation is found with the variable Loan &Advanced (PP-Y3) and the lowest with Operating Expense (.08).Again, the input variable Loan & Advanced (PP-Y3) has positive relation with the variables Fixed Assets (PP-Y4) (.64) and Shareholder Equity(PP-Y6) (.67).But it has also a negative relation with the variable Operating Expense (PP-Y5) (-0.03).In this case the highest and lowest relation exists between the variable Shareholder Equity (PP-Y6) (.67) and Operating Expense (PP-Y5) (-0.03) respectively.

Furthermore, the input variable Fixed Assets (PP-Y4) has significant positive relation with the input variable Operating Expense (PP-Y5) (.50) and Shareholder Equity (PP-Y6) (.71). Here it is seen that the highest relation exists between the variable Shareholder Equity (PP-Y6) (.71). The table also depicts that the input variable Operating Expense (PP-Y5) has a positive relation with the input variable Shareholder Equity (PP-Y6) (.21). From the above analysis it is noticeable that maximum time both the input and output variable has positive relation with one another. For this reason, the hypothesis "There is no positive correlation between the input and output variables of the Islamic and Conventional banks and is rejected under the variable return approach". And it is accepted that there is a positive relation between the input and output variable of the Islamic and Conventional bank.

There is no difference between the Islamic and the Conventional banks regarding the efficiency scores obtained by DEA

Table 8: T-Test under CRS Approach

	Islamic Bank	Conventional Bank
Mean	0.980524	0.979857
Variance	0.000395	0.00067
Observations	6	6
Pearson Correlation	-0.28606	
Hypothesized Mean Difference	0	
Df	5	
t Stat	0.044302	
P(T<=t) one-tail	0.483189	
t Critical one-tail	2.015048	
P(T<=t) two-tail	0.966379	
t Critical two-tail	2.570582	

From Table, it has been shown that the sample calculated t-value is.0443 and the sample tabulated t-value is 2.571 while P-value is 0.966. Since the sample calculated t-value is less than tabulated t-value and P-value is greater at 0.05 (level of significance) which means that null hypothesis is accepted. That is there is no significant difference between the Islamic banks and the conventional banks.

There is no difference between the Islamic and the Conventional banks regarding the efficiency scores obtained by DEA.

Table 9: T-Test under VRS Approach

	Islamic Bank	Conventional Bank
Mean	0.997595	0.988929
Variance	3.47E-05	0.000477
Observations	6	6
Pearson Correlation	0.017631	
Hypothesized Mean Difference	0	
Df	5	
t Stat	0.942998	
P(T<=t) one-tail	0.19449	
t Critical one-tail	2.015048	
P(T<=t) two-tail	0.38898	
t Critical two-tail	2.570582	

From Table, it has been shown that the sample calculated t-value is.943and the sample tabulated t-value is 2.571 while P-value is 0.389. Since the sample calculated t-value is less than tabulated t-value and P-value is greater than 0.05 (level of significance) which means that null hypothesis is accepted. That is there is no significant difference between the Islamic banks and conventional banks.

7. Conclusion sand Recommendations

Bank is a financial intermediary on which people rely on. In this modern age development of a country cannot be possible without banking activities. It supplies money which is considered as the blood for a business. This study measures the relative efficiency of 12 commercial banks (6are Islamic and the rest 6 are Conventional) of Bangladesh. It combines the DEA, t-test, coefficient of variances, partial productivity of efficiency score etc. The fact that all the products and services are approximately similar for all the banks ensures maximum feasible comparability among banks. Here the input variables are investment, interest expense, loan and advanced, fixed assets, operating expense, shareholder equity and the output variables are interest income and non-interest income. In the study it was found that there was significant correlation coefficient among the output and input variables both in the. O 1 level and. o5 level. For this reason, the hypothesis "there is no positive correlation of each of the partial productivity of inputs with efficiency scores obtained by DEA" was rejected. Again the hypothesis "there is no difference between the Islamic and the conventional banks regarding the efficiency scores obtained by DEA" was accepted by the t-test. It was

found that the technical efficiency under CRS approach was 100% for the DMU AABL, and BBL. The average efficiency score was 98%and the lowest score possessed by ABBL. Average technical efficiency for both Islamic and conventional banks was 98% and 98%.Under the VRS approach 9 banks got 100% efficiency score and the rest 3 banks possessed score under 100%.Here average score was 99%.Islamic banks possessed about 100 % efficiency while conventional banks was 99%.Here the lowest efficiency score was 95%. In case of scale efficiency, only two banks had the efficiency score 100% while rest 10 banks got the score under 100%.Here average efficiency score was 99% while the lowest efficiency score 94%.The average efficiency score for Islamic banks was 98% on the other hand the conventional Banks was 99%. IT is recommended that banks should invest in the profitable sectors. They should utilize their fixed assets properly. It is recommended that banks should make proper steps to reduce the overall extra operating expense.

8. References

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