Efficiency Analysis of Nationalized Commercial Banks Operating in Bangladesh: A DEA Approach

Dr. Muhammad Amir Hossain*

Abstract

There are mainly three types of Deposit Money Banks (DMBs) operating in Bangladesh, such as; Nationalized Commercial Banks (NCBs), Private Commercial Banks (PCBs) and Foreign Commercial Banks (FCBs). Among the DMBs four NCBs have been selected to compare their performances. The main objective of this study is to find out most efficient banks and how much inefficient the other banks are compared to most efficient banks. In the present study Data Envelopment Analysis (DEA) technique has been applied which is nonparametric in nature. Input oriented three models namely, Constant Returns to Scale (CRS), Variable returns to Scale (VRS) and Cost Efficiency DEA have been applied. In each of the models attempts have been made to work out Technical Efficiency (TE), Scale Efficiency (SE), Allocative Efficiency (AE) and Cost Efficiency (CE) of each bank separately. After applying these measures Agrani bank has been found as the most efficient bank and Sonali bank has been found as the least efficient bank during the period of study.

Key Words: Technical Efficiency, Scale Efficiency, Allocative Efficiency, Nonparametric, Data Envelopment etc.
JEL Classification: B22, C44, C51, E23, G21

Section I: Introduction

The importance of commercial banks to the socioeconomic development of a country cannot be ignored, both from developed and developing countries banks have shown a significant role in the development and growth of economy by ensuring prudent allocation of resources as well as their efficient utilization (Raphael, G. 2013). The analysis of performance is a subjective as well as a relative concept. The study of performance is necessary for further improvement of an organization. There are different types of commercial banks operating in Bangladesh such as; Nationalized Commercial Banks (NCBs), Private Commercial Banks (PCBs) and Foreign Commercial Banks (FCBs). State owned banks are two types such as; Commercial banks and Specialized banks. Although specialized banks have profit oriented activities, these banks are operating in special areas and purposes. The present research is attempted to analyze efficiency performance of State owned commercial banks. Presently, there are four NCBs namely, Sonali Bank Limited (SBL), Janata Bank Limited (JBL), Agrani Bank Limited (ABL) and Rupali Bank Limited (RBL). NCBs have some social responsibilities but profit earning motive cannot be avoided at all. All four NCBs have the same view and working under the guidance of government. In a comparative study among different types of banks it has been shown that performance of FCBs and PCBs are much better than performance of NCBs (Hossain, M. A. 2010). Therefore it is essential to increase efficiencies of NCBs to run their business in a competitive environment like Bangladesh. Before taking any policy decision regarding performance of NCBs, it is necessary to study their individual efficiencies and comparative efficiencies among them. In view of that sense, NCBs has been chosen for study in the present research.

The initial DEA model, as originally presented in Charnes, Cooper and Rhodes (1978), built on the earlier work of Farrell (1957). According to their name this model is also known as CCR model. The resulting measure which is referred to as the "Farrell measure of efficiency," was regarded by Farrell as restricted to meaning "technical efficiency" or the amount of "waste" that can be eliminated without

* Joint Director, Statistics Department, Bangladesh Bank, Head Office, Dhaka. The views expressed in this paper are author's own and no way reflects the opinion of Bangladesh Bank.

worsening any input or output. This was then distinguished by Farrell from "allocative" and "scale" efficiencies as adapted from the literature of economics.

Charnes et. al. (1978) developed and extended Farrell's idea into a non-parametric methodology known as Data Envelopment Analysis. Boles (1966) and Afriat (1972) suggested mathematical programming methods which could achieve the task although the method did not receive wide attention. There are only a few papers written on the cost efficiency of banks in the developing countries using the DEA method, such as Bhattacharya, Lovell and Sahay (1997) for India, Taylor, Thomsom, Thrall and Dharmapala (1997) for Mexico, Al-Faraj, Alidi and Bu-Bshait (1993) for Saudi Arabia.

There were some other studies relating to DEA techniques such as Saaid, Rosly, Ibrahim and Abdullah (2003) investigated efficiency regarding Sudanese Islamic banks. They showed that the Sudanese Islamic banks were not optimizing their inputs usage. They also showed that the inefficiency in the Sudanese Islamic banks could be more associated with inputs wasting rather than choosing the incorrect input combinations; In an empirical analysis of Islamic banks, Yudistira, D. (2004) showed that Islamic banks in a particular sample suffered from the global crisis in 1998-1999 but performed very well after the difficult periods; Primorac and Troscot (2005) dealt with the empirical measurement of relative technical efficiency of Croatian banks. It has been shown that the Malmquist index helps both central and commercial bank analysis to monitor trends within the banking sector; Hassan, Zubair (2005) provides an appraisal of some of the researches conducted in recent years for evaluating the recent year's efficiency of Islamic banks. He stated that stochastic frontier and data envelopment analysis models leave much to be desired and the conclusions they arrive at are of suspect validity for variety of reasons; Boshrabadi, Villano and Fleming (2006) reports on an analysis of technical efficiency and environment-technology gaps in wheat farming in Iran; Mattews and Ismail (2006) examined the technical efficiency and productivity of commercial banks in Malaysia. They found that foreign banks are more efficient than domestic banks. The main source of productivity growth is technical change rather than improvement in efficiency; Sufian (2006) showed an empirical evidence regarding efficiency of non-bank financial institutions of Malaysia by applying DEA method. His results suggest that the merchant banks have exhibited mean overall efficiency of 78.1% while the finance companies mean overall efficiency was 91.3%. Loukoianova (2008) analyzed the efficiency and profitability of Japanese banks. He used a non-parametric approach, the DEA, to analyze bank's cost and revenue efficiency. The results show that performance of Japanese banks has steadily improved since 2001, but there are significant differences within the banking sector, with regional banks being less cost and revenue efficient relative to both city and trust banks; Raphael, G. (2012) examined the relative efficiency of selected 20 commercial banks in Tanzania from 2008 to 2011. The findings were categorized based on two groups of commercial banks i.e., small and large groups. He observed that through make use of underutilized resources and reduce operating expenses most commercial banks will remain to be relative efficient in the productive frontier; In an efficiency analysis of commercial banks in East Africa, Raphael, G. (2013) concluded that inefficient utilization of input resources could be one of the reasons for the inefficiency of commercial banks in East Africa. There was a very limited study of efficiency analysis related to Bangladeshi commercial banks.

This article is divided into four sections. The first section includes the introduction and brief literature review. Second section explores the objectives and methodologies. The third section concentrates on empirical results. Finally, summary and conclusions have been incorporated in the fourth section.

Section II: Objectives and Methodologies

The broad objective of this study is to make a comparative analysis of performances of Nationalized Commercial Banks (NCBs) operating in Bangladesh. Specific objectives of this study are as follows:

- To measure the technical efficiency
- To measure the scale efficiency
- To measure the allocative efficiency
- To measure the cost efficiency and
- Compare efficiencies among selected banks

There are many input and output oriented measures of DEA methodology. In the present study five types of input oriented efficiency measures have been applied to test comparative performances of nationalized commercial banks. The measures are 1) Technical Efficiency under Constant Returns to Scale (TECRS) 2) Technical Efficiency under Variable Returns to Scale (TEVRS) 3) Scale Efficiency (SE) 4) Allocative Efficiency and 5) Cost Efficiency (CE).

Four nationalized banks have been selected to study comparative performances among them. The period of study has been covered from 2007 to 2011. The efficiency analysis has been performed among the banks for each individual period. In this study four inputs have been used to produce a single output for each bank i.e., DMUs. The inputs in our consideration are, Manpower Per Branch (MPB), deposits per branch (DPB), Investment Per Branch (IPB) and assets per branch (APB). On the other hand the one output in our consideration is Profit per Branch (PPB). The price information of selected input variables have also been considered to work out allocative efficiencies.

According to Farrell (1957) there are two types of broad measures of DEA, such as; Input-Oriented Measures and Output-Oriented Measures. The present study is attempted to apply input oriented measures. Let us consider there are M inputs and K outputs on each of N Decision Making Units (DMU's). In the present research DMUs will be considered as banks. If i-th DMU's inputs and outputs represented by xi and yi respectively, then X represents the input matrix of order MxN and Y represents the output matrix of order KxN.

The efficiency measurement (e_0) of a particular bank can be expressed as:

$$\text{Max } e_0 = \frac{\sum_{r=1}^{k} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \qquad (2.1)$$

Subject to the constraints

$$\frac{\sum_{r=1}^{k} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1;\ j = 1,2,\ldots,\ n$$

Where,

$$\frac{u_r}{\sum_{i=1}^{m} v_i x_{i0}} \succ \varepsilon; r = 1,\ldots, k$$

$$\frac{v_i}{\sum_{i=1}^{m} v_i x_{i0}} \succ \varepsilon; i = 1,\ldots,\ m$$

The model measures the relative performances of banks. There are n DMUs which are j = 1,2,……,n. In the model, $Y_{rj} > 0$ represent the rth output of jth bank and >0 represent the observed amount of ith input of jth bank; and represent the weights of rth output and ith input respectively; ε is a constant smaller than any positive valued real number for.

The CCR DEA model can be represented as a dual problem of maximization linear programming, such as;

$$\text{Min} \quad \theta_0 - \varepsilon \left[\sum_{i=1}^{m} s_i + \sum_{r=1}^{k} s_r \right]$$

Subject to the constraints

$$0 = \theta_0 x_{io} - \sum_{j=1}^{n} x_{ij}\lambda_j - s_i \text{ and } y_{ro} - \sum_{j=1}^{n} y_{rj}\lambda_j - s_r \qquad (2.2)$$

Where, θ_0 is the efficiency score of a particular DMU, λ_j is a vector of constants while s_i and s_r are nonnegative slacks associated with inputs and output inequalities respectively.

When all of DMU's are not operating in an optimal scale, CRS specification will result in measures of TE which are confounded by Scale Efficiencies (SE). The use of VRS specification will permit the calculation devoid of these scale effects. The CRS linear programming problem can be easily modified to account for VRS by adding the convexity constraint, $\sum_{j=1}^{n} \lambda_j = 1$ to equation 2.2.

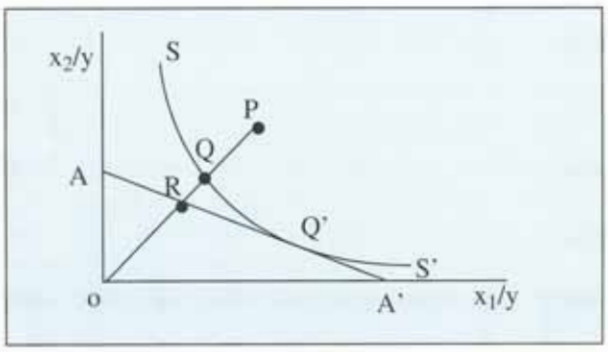
This approach forms a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency which may be different from those obtained using CRS model.

If a given firm uses quantities of inputs, defined by the point P to produce a unit of output, the technical inefficiency of that firm could be represented by the distance QP, which is the amount by which all inputs could be proportionally reduced without a reduction in output. This is usually expressed in percentage terms by the ratio $\frac{QP}{OP}$, which represents the percentage by which all inputs could be reduced. The technical efficiency (TE) of a firm is most commonly measured by the ratio

$$TE = \frac{OQ}{OP} \tag{2.3}$$

TE will take a value between 0 and 1, hence it provides an indicator of the degree of technical inefficiency of the firm. A value of 1 indicates the firm is fully technically efficient. For example, the point Q is technically efficient because it lies on the efficient isoquant.

Figure 2.1: Technical and Allocative Efficiencies



If the input price ratio, represented by the line AA' in figure 2.1 is known, allocative efficiency may also be calculated. The allocative efficiency (AE) of the firm operating at P is defined to be the ratio

$$AE = \frac{OR}{OQ} \tag{2.4}$$

Since the distance RQ represents the reduction in production costs that would occur if production were to occur at the allocatively (and technically) efficient point Q', instead of at the technically efficient, but allocatively inefficient point Q.

Section III: Empirical Results

3.1 Technical Efficiency under CRS

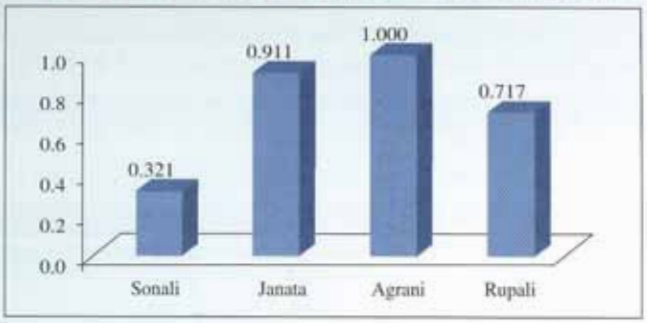
It is an input-oriented Constant Returns to Scale (CRS) Methodology based on cross-section data. In this research four inputs have been used to produce a single output for each type of banks i.e., DMUs. The inputs in our considerations are, Manpower Per Branch (MPB), deposit per branch (DPB), investment per branch (IPB) and assets per branch (APB). On the other hand the one output in our consideration is profit per branch (PPB). Inputs and output data for 5 years (2007-2011) have been analyzed separately.

Table 3.1: CRS Input Oriented DEA Results: 2011

DMUs	TECRS	λAgrani	λRupali	MPB Slack	DPB Slack	IPB Slack	APB Slack
Sonali	0.542	0.499	0.276	0.000	38.232	0.000	36.078
Janata	0.986	0.932	0.371	0.000	63.841	0.000	23.887
Agrani	1.000	1.000	---	0.000	0.000	0.000	0.000
Rupali	1.000	1.000	---	0.000	0.000	0.000	0.000
Mean	**0.882**	**---**	**---**	**0.000**	**25.518**	**0.000**	**14.991**

The table 3.1 shows that Agrani and Rupali are the full efficient banks whereas, Sonali is the least efficient bank among NCBs in 2011 under constant returns to scale. It is observed that Agrani and Rupali bank are the peer of Sonali and Janata bank. The table 3.1 also shows that efficiencies of Sonali bank is lying below the mean efficiency and efficiencies of other banks lying above the mean efficiency level. Efficiency measures means that Sonali and Janata bank are using more inputs to produce same level of output compared to Agrani and Rupali bank in 2011.

Figure 3.1: Mean TE of Last 5 Years Under CRS



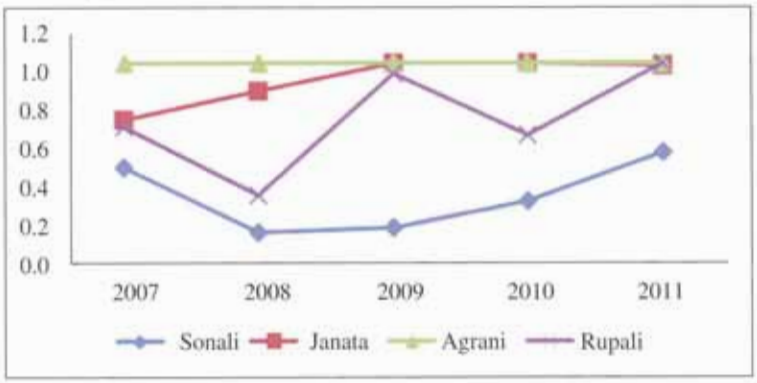
Using the DEA, it is observed that mean of the mean technical efficiency under CRS over the period under study is 73.7% (table 3.2). This implies that there is sufficient room for improvements in technical efficiency of NCBs. Table 3.2 and figure 3.1 shows that mean technical efficiency for the Agrani bank is the highest (100.0%) and for Sonali bank is the lowest (32.1%) during 2007-2011.

The figure 3.2 shows that TE for Agrani bank remains maximum and TE for Sonali bank remains minimum throughout the period of study.

Table 3.2: Mean Technical Efficiency under CRS

DMUs	2007	2008	2009	2010	2011	Mean
Sonali	0.470	0.134	0.161	0.296	0.542	0.321
Janata	0.711	0.859	1.000	1.000	0.986	0.911
Agrani	1.000	1.000	1.000	1.000	1.000	1.000
Rupali	0.677	0.328	0.944	0.635	1.000	0.717
Mean	**0.715**	**0.580**	**0.776**	**0.733**	**0.882**	**0.737**

Figure 3.2: Period and Bank-wise TE under CRS



3.2 Technical Efficiency under VRS

In the previous model it has been found technical efficiencies by considering Constant Returns to Scale (CRS). An attempt has been made to work out technical efficiencies in the present section by considering Variable Returns to Scale (VRS). This is another input-oriented DEA analysis using same output and inputs used in case of CRS. The VRS and CRS input-oriented DEA results for the year 2011 are listed in table 3.3 It has been observed that mean technical efficiency for all DMUs is 90.7% under VRS and 88.2% under CRS in 2011. The Janata, Agrani and Rupali banks are found as the efficient banks under VRS and Agrani and Rupali are found as efficient bank under CRS. On the other hand, Sonali bank has been found as the inefficient bank both in CRS and VRS in 2011.

Table 3.3: VRS Input Oriented DEA Results: 2011

Banks	CRSTE	VRSTE	SE	Scale
Sonali	0.542	0.630	0.860	irs
Janata	0.986	1.000	0.986	drs
Agrani	1.000	1.000	1.000	---
Rupali	1.000	1.000	1.000	---
Mean	**0.882**	**0.907**	**0.962**	

It is also observed that Agrani and Rupali bank are the most scale efficient and Sonali bank is the least scale efficient. The scale inefficiencies for Sonali and Janata are 14.0% and 1.4% respectively.

3.3 Allocative and Cost Efficiency

This is a CRS cost efficiency analysis using the four inputs and one output along with related cost data. In this case, the input and output variables remain same as in previous sections. In the model of discussion allocative efficiencies and cost efficiencies have been worked out for each bank in addition of technical efficiencies. The table 3.4 shows that, Agrani bank is the most efficient bank in terms of AE and CE in 2011. On the other hand Sonali bank has been found as the least cost efficient in 2011.

Table 3.4: CRS Cost Efficiency DEA Results: 2011

DMUs	TECRS	AE	CE
Sonali	0.542	0.779	0.433
Janata	0.986	0.863	0.851
Agrani	1.000	1.000	1.000
Rupali	1.000	0.583	0.583
Mean	**0.882**	**0.806**	**0.714**

After analyzing every year from 2007 to 2011, it has been observed that Agrani bank is found as the most efficient in terms AE and CE but Sonali bank has been found as the least efficient under the same measures.

3.4 Overall Performance in Last 5 Years

The table 3.5 shows the mean TECRS, TEVRS, SE, AE and CE of last 5 years. From the table it has been observed that Agrani bank is found as the full efficient and Sonali bank has been found as the least efficient in terms of TECRS, TEVRS, SE, AE and CE throughout the period of study. From the figure 3.3 it is observed that the mean efficiencies of Sonali, Janata, Agrani and Rupali bank are 49.9%, 90.7%, 100.0% and 79.2% respectively, which means that Sonali, Janata and Rupali bank are using 50.1 %, 9.3% and 20.8% more inputs compared to Agrani bank to produce same level of outputs. The figure 3.4 shows that all types of efficiencies are maximum in case of Agrani bank and the same measures are minimum for Sonali bank.

Table 3.5: Measure-wise Efficiencies in Last 5 years

Banks	TECRS	TEVRS	SE	AE	CE	Mean
Sonali	0.321	0.534	0.577	0.806	0.257	0.499
Janata	0.911	0.951	0.958	0.898	0.817	0.907
Agrani	1.000	1.000	1.000	1.000	1.000	1.000
Rupali	0.717	1.000	0.717	0.811	0.557	0.760
Mean	**0.737**	**0.871**	**0.813**	**0.879**	**0.658**	**0.792**

The average efficiency of all measures for each year has been listed in table 3.6. and also shown in figure 3.5. The table shows that mean efficiency level remains maximum for Agrani bank and remains minimum for Sonali bank throughout the period of study.

Table 3.6: Period-wise Efficiencies in Last 5 years

Banks	2007	2008	2009	2010	2011	Mean
Sonali	0.611	0.361	0.403	0.471	0.649	0.499
Janata	0.796	0.877	0.984	0.941	0.937	0.907
Agrani	1.000	1.000	1.000	1.000	1.000	1.000
Rupali	0.772	0.589	0.905	0.703	0.833	0.760
Mean	**0.795**	**0.707**	**0.823**	**0.779**	**0.855**	**0.792**

Figure 3.3: Mean of TE, SE, AE and CE of Last 5 Years

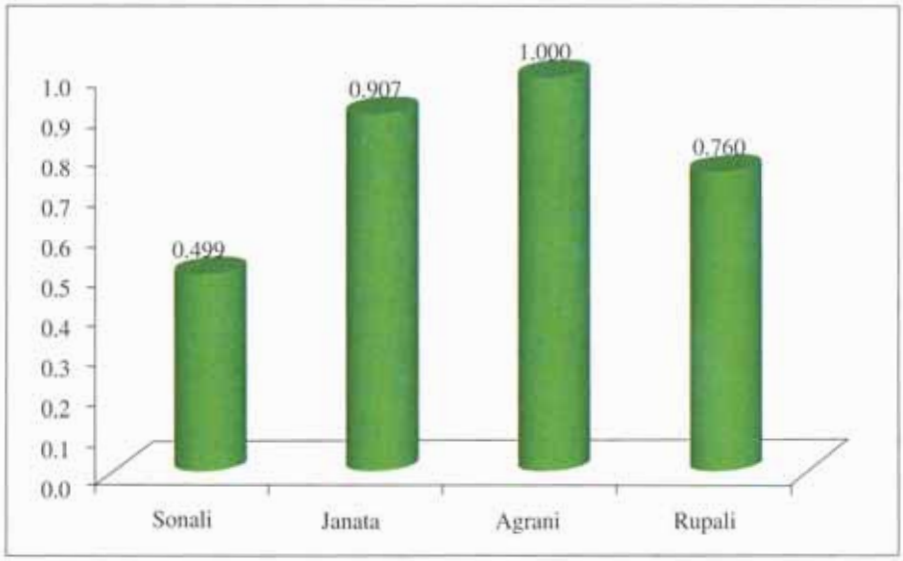


Figure 3.4: Measure and Bank-wise TE of Last 5 Years

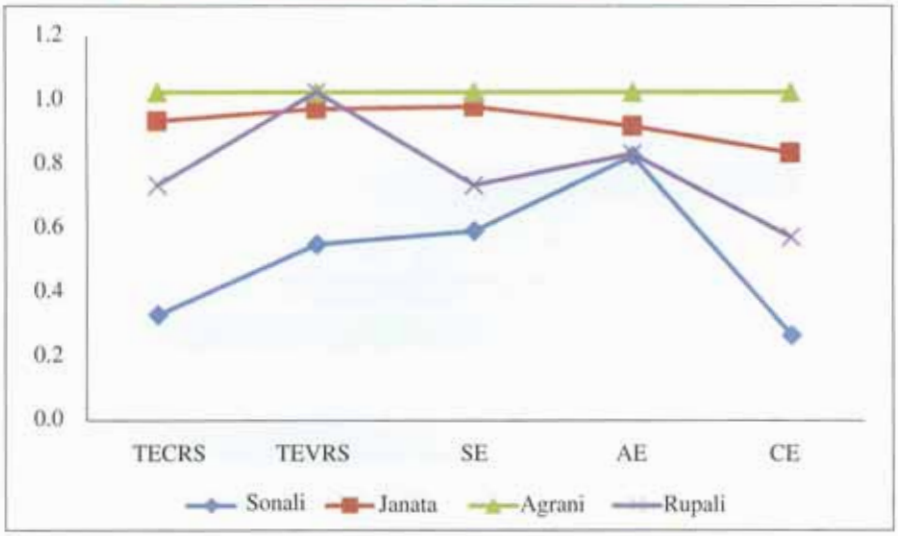
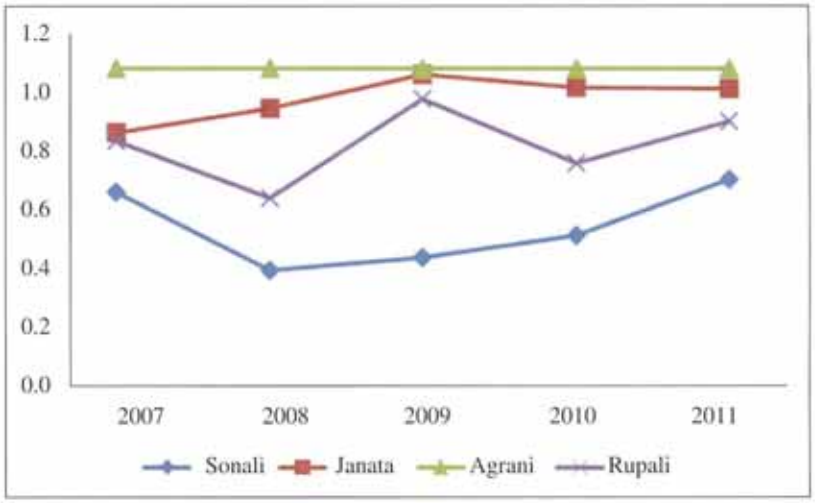


Figure 3.5: Period and Bank-wise Efficiencies (Mean of All Measures)



The results of table 3.5 could be validated by significant at the 5% level (2-tailed). The null hypothesis is that the rank correlation co-efficient between two efficient variables is zero. The empirical results of table 3.7 indicate that there is a satisfactory relationship among different efficiency measures. It is suggested that the various measures of banking efficiencies are satisfactorily associated with each other.

Table 3.7: Significance Test of Spearman's Correlation Coefficient among Efficiency Measures

	TECRS	TEVRS	SE	AE	CE
TECRS	1.000	---	---	---	---
TEVRS	0.759* (0.000)	1.000	---	---	---
SE	0.974* (0.000)	0.615* (0.004)	1.000	---	---
AE	0.500* (0.024)	0.398 (0.082)	0.458* (0.042)	1.000	---
CE	0.924* (0.000)	0.726* (0.000)	0.895* (0.000)	0695* (0.001)	1.000

**Significant at 5% level of significance*

Section IV: Summary and Conclusions

Five different measures have been applied in each of NCBs separately. In each of the measures it is attempted to work out efficiency performance of each bank separately. After analyzing performances of NCBs from 2007 to 2011 it is observed that Agrani bank has been found as the most efficient bank and Sonali bank has been found as least efficient bank in consideration of TECRS,

TEVRS, SE, AE and CE. Further analysis is needed to find out the reasons of inefficiencies of Sonali bank.

It is recommended that nationalized commercial banks specially, Sonali bank should minimize the use of input resources while maintaining the same level of output compared to other banks. By improving handling of operating expenses, advances, capital and by boosting banking investment operation, the less efficient banks can successfully endorse resource utilization efficiency. However the results of the analysis have important implications for management of the banks, policy makers and bank regulators in Bangladesh.

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