

Merger & Acquisition and Cost Efficiency: A DEA Approach

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Abstract

Efficiency, in general, defines the relationship between production and some desirable objective functions such as cost minimization or revenue and profit maximization at a given level of technology. The study investigates the cost efficiency of banking sector based on secondary data collected from CMIE Prowess Package over the period of 2010-2015. The present study has chosen Axis Bank, Kotak Mahindra Bank, ICICI Bank, Dhanalaxhmi Bank, Syndicate Bank and State Bank of India as sample units. The statistical methods used are descriptive statistics, Data Envelopment Analysis (DEA), Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). Based on the results, the study rejects hypotheses that there is no significant difference in the cost efficiency of sample banks based on the selected methods. Hence, the study suggests for acceptable overall level of efficiency during the testing period, with an average efficiency ranging from 0.94 to 1 and from 0.75 to 1 for CRS and VRS respectively. The results prove that reduced investment in equity followed by more loan & advance creation is the most effective method for improving the operational efficiency of inefficient banking firms.

Key words: Mergers and acquisitions, Data Envelopment Analysis, Cost efficiency, Constant returns to scale model, Variable returns to scale model.

JEL: G34, D61.

Introduction

Cost efficiency (CE) is a measure to show how far the input and output of the best practice of bank cost in producing in the same environmental conditions. One can ensure cost efficiency of a bank employing either non-parametric or parametric approaches. The non-parametric (non-stochastic) cost efficiency is calculated by employing linear mathematical programming techniques while the parametric (stochastic) cost efficiency is derived from a cost function in which variable costs depend on the input prices, quantities of variable outputs, random error, and inefficiency.

The firm, generally, faces a degree of competitiveness in input and output markets, and it's rationale economic behavior that aims to

maximize the production by choosing either optimal input mix under cost minimization or optimal output under the revenue maximization objective.

Data Envelopment Analysis Approach (DEA)

Data Envelopment Analysis (DEA) constitutes one of the productivity measurement methods and performance evaluation of one firm's activity using non-parametric approach, which is basically a linear programming based technique. It was Charnes *et al.* (1978), who first proposed this method.

The term Decision Making Unit (DMU) can be used for various units, such as banks, hospitals, retail stores, and whatever unit which has the similarity to the operational characteristics. Further, comparison between input and output will result in efficiency value. According to DEA method, efficiency constitutes a relative value instead of absolute value achieved by a unit. The DMU with the best performance will reach 100% efficiency, however other DMUs below this performance will have varying efficiency, i. e. 0 - 100%.

Review of Literature

Maudos and Pastor (2003)¹, in a study titled “Cost, revenue, and profit efficiency in the Spanish Banking Sector (1985-1996): A non-parametric approach” analysed the efficiency in costs and profits of 98 Spanish banking sector (SBS) in the period 1985-96 using a non-parametric approach. The data were collected from balance sheets and profit and loss accounts of the commercial and savings banks. The study used descriptive statistics, and correlation coefficients as research tools. The results referring to 1996 indicated that the return on assets (ROA) and return on equity (ROE) of the Spanish Banking sector was increased by 2.4 and 24.4 respectively for ROA and ROE, eliminating the combined inefficiency in costs and revenues.

Mohammed *et al.* (2008)², in a study titled “Cost, revenue, and profit efficiency of Islamic versus Conventional Banks: International evidence using Data Envelopment Analysis” examined 43 Islamic and 37 Conventional banks during the period from 1990 to 2005. The study used descriptive statistics and Kruskal-Wallis (H) test for analysis besides using Data Envelopment Analysis (DEA) method to measure the cost, revenue, and profit efficiency of Islamic versus Conventional banks. The findings of the study suggested that there were no significant differences between the overall efficiency results of Islamic banks versus Conventional banks in respect of cost, revenue and profit efficiency.

Pardeep and Gian (2010)³, in a study titled “Impact of mergers on the cost efficiency of Indian commercial banks” analyzed cost efficiency of Indian commercial banks using a non-parametric Data Envelopment Analysis (DEA)

technique. The study was based on unbalanced panel data over the period from 1990-91 to 2007-08, which tested the efficiency differences between public and private sector banks using both parametric & non-parametric tests. The study showed that over the study period, average cost efficiency of public sector banks was found to be 73.4 and that of for the private sector was 76.3 %.

Liargovas and Repousis (2011)⁴, in a study titled “The impact of mergers and acquisitions on the performance of the Greek Banking sector: An event study approach” examined the impact of Greek mergers and acquisitions on the performance of the Greek banking sector during the period 1996-2009. The study was based on 20 financial accounting ratios viz., return on equity (ROE), return on assets (ROA), net profit margin (NPM) net income margin (NIM), etc. The study stated that the bank mergers and acquisitions have no impact on the operating performance of Greek Banking sector.

Rossazana Collins *et al.* (2012)⁵, in a study titled “The cost efficiency effects of involuntary bank mergers: Evidence from the Malaysian banking industry” attempted to quantify the impact of the involuntary merger and acquisition on the cost efficiency gains over the period 1990-2005. The study used Data Envelopment Analysis (DEA) method to measure the cost efficiency of Malaysian banking sector. The study assessed the cost, allocative, technical, pure technical and scale efficiencies of Malaysian banking industry as the result of the merger and acquisition. The used variables (size, economic growth, market concentration, risk and the government ownership) are regressed on each type of the cost efficiency using the Tobit regression model approach, a bootstrapping technique and used several tests (t-test, Wilcoxon rank-Sum, Kruskal-Wallis, Mann-Whitney and Kolmogorov-Smirnov). The study showed that the enforcement of the bank merger policy has resulted in to an improvement of bank efficiency level.

Devarajappa (2012)⁶, in a study titled “Mergers in Indian banks: A study on mergers of HDFC Bank Ltd and Centurion Bank of Punjab Ltd” compared pre and post-merger financial performance of merged banks considering financial parameters viz., gross profit margin (GPM), net profit margin (NPM), operating profit margin (OPM), return on capital employed (ROCE), return on equity (ROE), and debt equity ratio (DER). The data were collected from Indian banking industry and banks' annual reports. The pre-merger (three years' prior) and post-merger (three years after) performance was studied using financial ratios. The study showed that the banks were positively affected by the event of merger and acquisition.

Adekule and Ayorinde (2012)⁷, in a study titled “Effects of merger and acquisition on the performance of selected commercial banks in Nigeria” used secondary data collected

through compilation and extracts from published data including published audited financial accounts of sampled banks from 2001 to 2010. The selected variables viz., gross earnings, profit after tax and deposit profile of seven Nigerian commercial banks were used. The study showed that, in the post merger and acquisition period, the banks have significantly improved their financial performance when compared to the pre-merger and acquisition period.

Sharma (2012)⁸, in a study titled “Impact of mergers & acquisition on financial performance: With special reference to Tata Group” examined some pre and post merger and acquisition financial ratios, with the sample firms chosen for the period from 2003-2004 to 2007-2008, which includes three years' data of pre-merger and of post-merger acquisition periods respectively of the 24 firms of Tata group which involved in the merger and acquisition. The study has taken mean pre-merger and acquisition and mean post-merger and acquisition ratios. The results on financial performance of the pre and post-merger and acquisition periods of the Tata group firms reveals that there was no significant change (increase / decrease) in the financial ratios i.e. the merger and acquisition has not significantly affected the financial performance of Tata group firms either way.

Kanahalli and Jayaram (2014)⁹, in a study titled “Financial performance of Tata Motors Firm Ltd: A post-merger analysis” explored the potentialities and capabilities of the firm by studying pre and post merger and acquisition performance. The study was based on secondary data. In order to evaluate financial performance, ratio analysis, and standard deviation and t-Test were used as tools of analysis. The study showed that the merger and acquisition of the selected firm has resulted in to significant difference between pre and post-merger financial performance.

The review of the past literature drew attention to the difference of mergers & acquisition on cost efficiency in Indian banking sector. However, the studies related to previous literature Pardeep and Gian (2010) and Rossazana Collins *et al.* (2012) shows the difference between Separate and Common frontier for public and private banks. Further, mergers & acquisition on cost efficiency in banking sector is good. Majority of the studies include many input variables used (advance, non-interest income and spread) with output variables used (labour, loanable funds and physical capital) and also it included the variables of assets, equity, employees, total income and loans & advances, Constant Returns to Scale and Variable Returns to Scale, which was not considered in the previous studies.

Objectives

To analyse the cost efficiency of Axis Bank Ltd, Kotak Mahindra bank, ICICI bank, Dhanalaxhmi Bank, Syndicate Bank and State Bank of India in respect of Constant Returns

to Scale.

To analyse the cost efficiency of Axis Bank Ltd, Kotak Mahindra Bank, ICICI Bank, Dhanalaxhmi Bank, Syndicate Bank and State Bank of India in respect of Variable Returns to Scale.

Hypotheses of the Study

H₀¹: “There is no significant difference in the cost efficiency of Axis Bank Ltd, Kotak Mahindra Bank, ICICI Bank, Dhanalaxmi Bank, Syndicate Bank and State Bank of India in respect of Constant Returns to Scale”.

H₀²: “There is no significant difference in the cost efficiency of Axis Bank Ltd, Kotak Mahindra Bank, ICICI Bank, Dhanalaxmi Bank, Syndicate Bank and State Bank of India in respect of Variable Returns to Scale”.

Research Methodology

The study is based on secondary data which are collected from the Centre for Monitoring Indian Economy (CMIE) Pvt. Ltd., academic research journals, and other published sources.

Sampling Design

In order to test the stated hypotheses and to address the objectives of the study, the present study has chosen 6 sample bank units from merged banks in India during the period from 2010 to 2015.

Research Methods

The study used descriptive statistics viz., mean, standard deviation, and cost efficiency index using Data Envelopment Analysis (DEA), *constant returns to scale (CRS)* and *variable returns to scale (VRS)* models.

Variables used for Analysis

The following input and output variables are used for analysis;

(a) Input variables

X₁= Assets

X₂= Equity

X₃= Employees

(b) Output variables

Y₁= Total income

Y₂= Loans and advance

Ratios used for Analysis

a. Return on Assets Ratio (ROA)

It is an indicator of how profitable a firm is relative to its total

assets. Return on assets (ROA) gives an idea as to how efficient management it is in using its assets to generate earnings. Calculated by dividing a firm's annual earnings by its total assets, ROA is expressed as a percentage. Sometimes this is referred to as return on investment (ROI) also.

$$\text{Return on Assets} = \frac{\text{Net Income}}{\text{Total Assets}} \times 100$$

a. Return on Equity Ratio (ROE)

The amount of net income returned as a percentage of shareholders' equity. Return on equity measures a firm's profitability by revealing how much profit a firm generates with the money shareholders have invested.

$$\text{Return on Equity} = \frac{\text{Net Income}}{\text{Shareholders' Equity}} \times 100$$

Cost Efficiency

The non-parametric methodology for calculating cost efficiency, let us suppose consider that there exists N firms ($i=1, \dots, N$) that produce a vector of q OUTPUTS $y_i=(y_{i1}, \dots, y_{iq}) \in R^{q+}$ that they sell at prices $r_i=(r_{i1}, \dots, r_{iq}) \in R^{q+}$ using a vector of P inputs $x_i=(x_{i1}, \dots, x_{ip}) \in R^{p+}$ for which they pay prices $w_i=(w_{i1}, \dots, w_{ip}) \in R^{p+}$. The cost efficiency for the case of firm j can be calculated by solving the following problem of linear programming:

$$\begin{aligned} \text{Min} \quad & \sum_p w_{pj} X_{pj} \\ \text{s.t.} \quad & \sum \lambda_i Y_{iq} \geq Y_{iq} \\ & \sum \lambda_i \leq Y_{iq} X_{ipj} \\ & \sum \lambda_i = 1; \lambda_i \geq 0; i = 1, \dots, N \end{aligned}$$

The solution to which, $x_j = (x_{j1}^*, \dots, x_{jp}^*)$ corresponds to the input demand vector which minimizes the costs with the

given prices of inputs, and is obtained from a linear combination of firms that produces at least as much as of each of the outputs using the same or less amount of inputs. If this hypothetical firm had the same input price vector as firm j it would have a cost

$$C_j^* = \sum_p w_{pj} X_{pj}^*$$

Which, by definition, will be less than or equal to that of firm j ($C_j = \sum_p w_{pj} X_{pj}$).

Having obtained the solution to the problem the cost efficiency for firm j (CE_j) can be calculated by:

$$CE_j = \frac{C_j^*}{C_j} = \frac{\sum_p W_{pj} X_{pj}^*}{\sum_p W_{pj} X_{pj}}$$

Where $CE_j \leq 1$ represents the ratio between the minimum costs (C_j^*) – associated with the use of the input vector ((X_j^*)) that minimizes costs – and the observed costs (C_j) for firm j .

Analysis and Discussion

The study has used descriptive statistics of input and output variables of banks and the results are presented in table 1 followed by two important models for cost efficiency viz., constant returns to scale (CRS) and variable returns to scale (VRS) and the results are shown in the tables from 2 to 7. The table 1 reveals that the input variables viz., total assets, total equity, and total employees ranges from 861829.4 to 100286602.3; 7362.3 to 69317.2; 1315995 to 13844 with mean 29218682.25, 34338.26, 365787 respectively for X1, X2 and X3. However, the standard deviation records at 14990312.52, 8585.03, and 196923.87 respectively for X1, X2 and X3. The table further reveals that the output variables viz., total income (Y1) and loans and advances (Y2) ranges from 82327.2 to 8658209.4 and from 0 to 498179.4 with mean 2587920.7 and 98474.25 and standard deviation 1287683.21 and 81031.69 respectively for Y1 and Y2 for the study period.

Table 1
Descriptive Statistics for Inputs and Outputs

Input / output	Variables	Min	Max	Mean	S.D
Input Variables	X ₁	861829.4	100286602.3	29218682.25	14990312.52
	X ₂	7362.3	69317.2	34338.26	8585.03
	X ₃	1315995	13844	365787	196923.87
Output Variables	Y ₁	82327.2	8658209.4	2587920.7	1287683.21
	Y ₂	0	498179.4	98474.25	81031.69

Source: Computed results based on compiled data collected from CMIE Prowess Package.

Note: Input variables: X₁= Total Assets, X₂= Total Equity, X₃=Total Employees;
Output variables: Y₁=Total Income, Y₂=Loans and Advances.

Table 2
Average Financial Ratios (ROA and ROE) per Bank for the period from 2010 to 2015

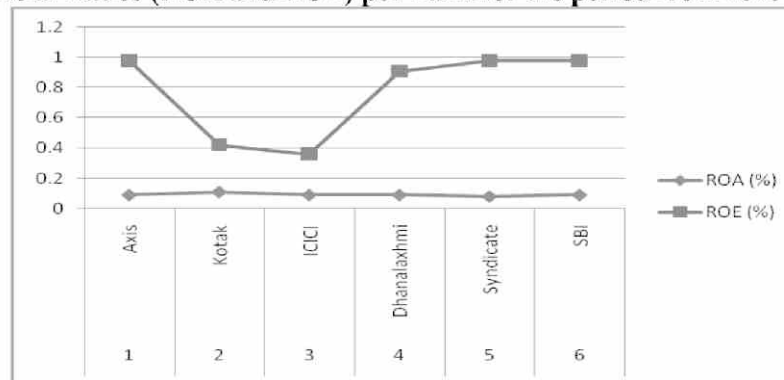
Sl. No.	Bank	ROA (%)	ROE (%)
1	Axis Bank	0.09	0.98
2	Kotak Mahindra Bank	0.11	0.42
3	ICICI Bank	0.09	0.36
4	Dhanalaxhmi Bank	0.09	0.91
5	Syndicate Bank	0.08	0.98
6	SBI Bank	0.09	0.98

Source: Computed results based on compiled data collected from CMIE Prowess Package.

Note: ROA = Return on Assets; ROE= return on Equity

An attempt has been made to study the financial ratios viz., followed by other banking units. However, with respect to return on assets (ROA) and return on equity (ROE) of the selected banks and the results are presented in table 2 followed by figure A. The results show that banks Kotak Mahindra Bank has more efficiency in respect of (0.11 %) ROA and ICICI Bank (0.36%) ROE, Axis Bank, Syndicate Bank and SBI Bank have more efficiency (0.98 %) followed by other banking units Dhanalaxmi Bank (0.91%); Kotak Mahindra Bank (0.42%);

Figure A
Average Financial Ratios (ROA and ROE) per Bank for the period from 2010 to 2015



Source: Computed results based on compiled data collected from CMIE Prowess Package.

Note: ROA = Return on Assets; ROE= Return on Equity

Table 3
Results of Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) Models

DMU No.	Bank Name	Efficient Input Target			Efficient Output Target	
		Assets (X ₁)	Equity (X ₂)	Employees (X ₃)	Total Income (Y ₁)	Loans and Advances (Y ₂)
1	Axis Bank	21762261.10	27097.40	222954.00	2074313.30	5951.50
2	Kotak Mahindra Bank	4999909.29	22696.00	89170.00	557511.80	0.00
3	ICICI Bank	30586724.98	55761.35	354084.51	3002295.40	6897.32
4	Dhanalaxhmi Bank	861829.40	7362.30	13844.00	82327.20	3424.40
5	Syndicate Bank	14122611.80	37258.90	167509.00	1152867.10	83290.20
6	SBI Bank	100286602.29	42297.80	1315994.99	8658209.40	498179.40

Source: Computed results based on compiled data collected from CMIE Prowess Package.

Note: CRS - Constant Returns to Scale; DMU - Decision Making Unit.

Note: Input variables: X₁= Total Assets, X₂= Total Equity, X₃=Total Employees;

Output variables: Y₁=Total Income, Y₂=Loans and Advances.

The results of the constant returns to scale (CRS) and variable returns to scale (VRS) models of efficient input target and efficient output target of banks are presented in table 3. The table reveals the efficient input target variables viz., total assets (X_1), total equity (X_2), and total employees (X_3) and the efficient output target variables viz., total income (Y_1) and loans and advances (Y_2). It is inferred that variable, equity (X_2) has the minimum input value as 27097.40 and maximum input assets (X_1) value as 21762261.10 for Axis Bank, while the output minimum loans and advances (Y_2) value as 5951.50 and maximum total income (Y_1) value as 2074313.30.

Kotak Mahindra Bank equity (X_2) has the minimum input value as 22696.00 and the maximum assets (X_1) value of input as 4999909.29, while the output minimum loans and advances (Y_2) value as 0 and maximum total income (Y_1) value as 557511.80. The ICICI Bank has the minimum

equity (X_2) value as 55761.35 and maximum assets (X_1) value as 30586724.98, while the output minimum loans and advances (Y_2) value as 6897.32 and maximum income value as 3002295.40. The Dhanalaxmi Bank equity (X_2) has minimum value as 7362.30 and maximum assets (X_1) value as 861829.40, while the output minimum loans and advances (Y_2) value as 3424.40 and maximum total income (Y_1) value as 82327.20. The Syndicate Bank has the input minimum equity (X_2) value as 37258.90 and maximum assets value (X_1) as 14122611.80, while the output minimum loans and advances (Y_2) value as 83290.20 and maximum total income (Y_1) value as 1152867.10. The SBI Bank equity (X_2) has input minimum value as 42297.80 and maximum assets value (X_1) as 100286602.29, while the output minimum loans and advances (Y_2) value as 498179.40 and maximum total income value (Y_1) as 8658209.40.

Table 4
VRS Model Slack Variable Analysis for the period from 2010 to 2015

DMU No.	Bank Name	Input Slacks			Output Slacks	
		Assets (X_1)	Equity (X_2)	Employees (X_3)	Total Income (Y_1)	Loans and Advances (Y_2)
1	Axis Bank	0	0	0	0	0
2	Kotak Mahindra Bank	0	0	0	0	0
3	ICICI Bank	0	39142.47	3039.05	0	75329.67
4	Dhanalaxhmi Bank	0	0	0	0	0
5	Syndicate Bank	0	0	0	0	0
6	SBI Bank	0	0	0	0	0

Source: Computed results based on compiled data collected from CMIE Prowess Package.

Note: Input variables: X_1 = Total Assets, X_2 = Total Equity, X_3 =Total Employees;
Output variables: Y_1 =Total Income, Y_2 =Loans and Advances.

The results of the analysis of variable returns to scale (VRS) model of efficient input slacks and efficient output slacks of banks are presented in table 4. The ICICI bank exhibits an excess of `39142.47 in equity with a shortage of `75329.67 in

loans and advances. However, use of DEA-CRS and DEA-VRS with an output-oriented assumption allows us to estimate the target for measuring and explaining the determinants of each firm's cost efficiency.

Table 5
Average Efficiency during the period from 2010 to 2015

DMU No.	Bank Name	CRS Efficiency	VRS Efficiency	Scale Efficiency	RTS
1	Axis Bank	1.00	1.00	1.00	Constant
2	Kotak Mahindra Bank	1.00	1.00	1.00	Constant
3	ICICI Bank	0.91	0.98	0.92	Decreasing
4	Dhanalaxhmi Bank	1.00	1.00	1.00	Constant
5	Syndicate Bank	1.00	1.00	1.00	Constant
6	SBI Bank	1.00	1.00	1.00	Constant

Source: Computed results based on compiled data collected from CMIE Prowess Package.

Note: CRS - Constant Returns to Scale, VRS - Variable Returns to Scale, RTS - Returns to Scale; DMU - Decision Making Unit.

The results of the average efficiency of CRS, VRS and Scale efficiency of banks during the period from 2010 to 2015 are presented in table 5. The average of CRS, VRS, and scale efficiency scores of Axis, Kotak, Dhanalaxmi, Syndicate

and SBI reached 1, which indicates that they are at an optimal level of efficiency, however the ICICI is still an inefficient, although its' average CRS, VRS, and scale efficiency are close to 1.

Table 6
CRS Model Slack Variable Analysis for the Period from 2010 to 2015

DMU No.	Bank Name	Input Slacks			Output Slacks	
		Assets (X ₁)	Equity (X ₂)	Employees (X ₃)	Total Income (Y ₁)	Loans and Advances (Y ₂)
1	Axis Bank	0	0	0	0	0
2	Kotak Mahindra Bank	0	0	0	0	0
3	ICICI Bank	0	7948.30	0	0	6897.32
4	Dhanalaxhmi Bank	0	0	0	0	0
5	Syndicate Bank	0	0	0	0	0
6	SBI Bank	0	0	0	0	0

Source: Computed results based on compiled data collected from CMIE Prowess Package.

Note: Input variables: X₁= Total Assets, X₂= Total Equity, X₃=Total Employees;
Output variables: Y₁=Total Income, Y₂=Loans and Advances.

The results of the CRS model slack variable analysis of input slacks and output slacks for banks for the period from 2010 to 2015 are presented in table 6. The ICICI bank exhibits an excess of `7948.30 in equity with a shortage of `6897.32 in loans and advances. However, use of DEA-CRS and DEA-VRS with an output-oriented assumption allows us to estimate the target for measuring and explaining the determinants of each firm's cost efficiency.

Findings

All firms surveyed, using the DEA approach, have an acceptable level of efficiency, with CRS scores ranging from 0.94 to 1.00, whereas VRS efficiency scores range from 0.75 to 1.00. the sum of lambdas scores range from 1.00 to 2.23. The average of CRS, VRS, and scale efficiency scores of Axis bank, Kotak bank, Dhanalaxhmi bank, Syndicate bank and SBI bank reached 1, which indicates that they are at an optimal level of efficiency, however the ICICI bank is still an inefficient, although its' average CRS, VRS, and scale efficiency are close to 1. This implies that most of the large size DMUs and their small counterparts are operating at a suboptimal level of efficiency. Therefore, necessary measures should be taken to improve their operational performance for cost efficiency. The results from the study suggest that inefficient firm needs improvement. For instance, the ICICI bank exhibits an excess of `7948.30 in equity with a shortage of `6897.32 in loans and advances. However, use of DEA-CRS and DEA-VRS with an output-oriented assumption allows us to estimate the targets for measuring and explaining the determinants of each firm's

performance and cost-efficiency.

Conclusion

The results derived from the DEA approach shows that all the selected firms achieved an acceptable overall level of cost efficiency during the testing period, with an average CRS efficiency ranging from 0.94 to 1 and VRS efficiency ranging from 0.75 to 1. Hence, based on the results, the study rejects Ho¹ and Ho², i.e. no significant difference in the cost efficiency of Axis Bank Ltd, Kotak Mahindra Bank, ICICI Bank, Dhanalaxhmi Bank, Syndicate Bank and State Bank of India in respect of Constant Returns to Scale and Variable Returns to Scale. The slack variable analysis indentified possible ways to improve the performance and cost efficiency of those inefficient firms. The reduced investment in equity followed by more loans and advances creation is the most effective method for improving the operational performance and cost efficiency of inefficient firms. The findings of the study can hopefully benefit managers of inefficient bankers to help enable them restructure their organizational scope and business style and review resource utilization for improving their operational performance and cost-efficiency.

Limitations and Scope for Further Studies

- In the present study, a sample of six firms of banking sector has been considered for analysis. In future, researchers can consider inclusion of more number of banking firms by referring to the other data sources and take up a study with large sample units to explore further

- results.
- In the present study, descriptive statistics, Data Envelopment Analysis, parametric and non-parametric test, Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) models are only used for analysis; therefore future researches may appropriate advanced models, which may bring a differing inference.

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