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Evaluation of Post-Merger Performance of Select Bse- Listed Indian Companies – A Systematic Study Using Data Envelopment Analysis

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Abstract

This paper tries to find the post-merger impact in comparison with pre-merger period on BSE-listed 50 companies or decision-making units (DMUs) those underwent merger between 01.04.2013 to 31.03.2014 with its 5 years pre-period and post-period average data by applying standard Data Envelopment Analysis (DEA) in a specific input-output combination. Input oriented DEA model is used here to analyze the impact in post-merger scenario on different parameters like efficiency score, return to scale, ranking etc. The results of the study find that due to the merger CCR scores of the DMUs deteriorated during post-merger period in comparison with pre-merger period but the scale efficiency improved in some of the DMUs which is a positive sign for those DMUs. But the ranking of the DMUs according to PTE scores deteriorated after the merger in comparison with pre-merger period.

Keywords: BSE, DEA, Efficiency Measurement, Scale measurement, Merger.

Introduction

One of the effective and useful method for assessing a company's or DMUs performance by a non-parametric method after the merger is Data Envelopment Analysis (DEA). The DEA offers important insights into the operational and financial synergies produced by M&As by comparing the efficiency of combined entities against their pre-merger counterparts and industry peers. In order to examine how mergers affect a firm's performance, this study uses DEA, with a particular focus on [aspects such as productivity, scale efficiency, or technical efficiency]. This study evaluates the long-term impacts of M&As on firm performance using a comprehensive dataset of 50 mergers from the BSE database over five years prior to and five years following the merger year. The study's conclusions refine our understanding of the efficiency gains and losses connected to merger activity, adding to the body of knowledge already available on M&As. Corporate strategists, decision-makers, and investors looking to minimize risks and maximize merger outcomes should take note of the significant implications our research holds for them.

Literature Review

Impact of mergers and acquisitions (M&A) specifically on the profitability on the banking sector of Malaysia was analysed by using a three-stage data envelopment analysis (DEA) was conducted by Sufian (2009). Various parametric and non-parametric tests were employed to investigate shifts in the banking system's efficiency before and after the merger. Finally, panel regression analysis was used to assess the banks' effectiveness while accounting for contextual factors. The analysis of seven merger scenarios revealed that the acquiring bank's profit efficiency increased in six of them.

Variety of statistical techniques, including paired sample t-tests, DEA, and t-statistics, used by Lai et al. (2015) to examine performance of Malaysia's banking sector after 2000. Researchers found that there had been no discernible improvement in the combined banks' performance or efficiency.

This research paper was investigated by Nguyen et al., (2022) to find the efficiency levels of 30 Vietnamese commercial banking institutions those was merged from 2011 to 2019 using a specific DEA approach. After that by using a specific regression, this paper indicates that mergers and acquisitions have a detrimental impact on bank efficiency.

This article by Wanke et al., (2017) conducts an analysis on M&A in South African banking institutions to calculate the impact of specific factors on the resulting virtual merged banks' efficiency ratings, a network DEA approach is used. The impact of specific variables relating to the bank's origin and kind is investigated using a series of robust regression that handle dependent variables bounded in 0 and 1that is Tobit, Simplex, and Beta. The results showed that bank type and origin have an impact on virtual efficiency. The study concluded that scale and harmony effects are insignificant because of South Africa's oligopolistic banking system.

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In this study Halkos and Tzeremes (2013) utilized a specific DEA procedure to estimate the short-term impact of M&A on operational efficiency enhancements of potential 45 banking industry of Greek between 2007 and 2011. It was revealed that the majority of proposed bank mergers did not yield short-term operating efficiency advantages in the year preceding and following the time of the Greek economic crisis. However, the results from 2011 indicated that most bank M&A could lead to short-term operational efficiency benefits. In the end, the empirical results confirmed the idea that efficient bank M&A is not always guaranteed by the merger or acquisition of other efficient banks.

After comparing the banks' pre- and post-merger efficiency in the three years prior to and following the merger, Jayaraman et al. (2014) used DEA to analyze the impact and effectiveness of Indian banking sector following M&A. In order to determine the precise effects of the merger, this study made a comparison between the banks those are already merged with the non-merged banks. The closeness of banks to the efficient frontier was ascertained by interval estimation. According to the research, the combined banks' technical efficiency first declined after the merger but then improved in the third year. Additionally, the study discovered that during the early stages of a merger, there was no discernible effect of M&A on the combined banks' profitability and operating expenses.

The article by Lin et al. (2020) recommended handling mergers and acquisitions (M&A) matching by DEA approach. Technical and scale efficiency measures were considered in order to establish reliable matching degrees between target and acquiring companies. In particular, the scale return of the combined decision-making units (DMUs) was ascertained using a traditional DEA model, whereas a reverse DEA model was developed to evaluate technical efficiency. An optimization model was then developed to generate comparable outcomes with the goal of improving DMU performance. To illustrate the suggested strategy, an analysis of M&A matching in Turkish energy companies was carried out, which revealed that scale efficiency and technical efficiency have a major impact on M&A matching practices.

The research examined the cost effectiveness of the banking industry by analysing secondary data from CMIE Prowess covering the period from 2010 to 2015 for specific banks in India by Silambarasan and Azhagaiah (2016). The analysis was conducted by using descriptive statistics and DEA methodology, and the outcome/result of the study refute the notion that there is no significant variation in the cost effectiveness of the sample banks based on the methodologies employed. Consequently, the study indicates a satisfactory overall level of efficiency during the evaluation period, with average efficiency ranging from 0.94 to 1 under CRS and from 0.75 to 1 under VRS. The results demonstrate that minimizing investment in equity in favour of increased loan and advance creation is the most efficient approach for enhancing the operational efficiency of underperforming banking companies.

This research conducted a practical evaluation of the consolidation of commercial banks in Gulf countries by Gattoufi et al., (2009). The study utilized DEA to assess the effect of M&A on the operational efficiency of banks participating in the consolidation. During the period of 2003-2007, the study examined 42 commercial banks, 10 of which were engaged in consolidation activities. The primary finding was that, there is a favourable impact of M&A on the commercial banks' performance. Additionally, the majority of banks those underwent M&A experienced an improvement in their performance surpassing the average companies/banks achieved, thus enhancing their performance at a faster than the market scenario.

This research by Bai et al., (2019) intertwines resampling DEA with the prospective benefits of mergers model to preliminarily assess efficiency enhancements of 3 notable M&A strategies namely, regional M&A, megamerger, and an alliance among the ‘strong’ and ‘weak’ railway bureaus within China's railway domain during the years 2011–2015. The findings indicate that geographically relevant M&As outperform the other two categories in generating efficiency improvements, owing to the unique nature of the railway industry – characterized by network economics. A well-executed M&A can induce a so-called ‘stimulant’ effect in the immediate term, yet as the ‘stimulant's power’ diminishes with time, the impact of the M&A will gradually wane. At this juncture, it becomes especially crucial for policymakers to implement a series of advantageous regulations. Ultimately, the empirical evidence illustrates the notion that a merger involving two (whether efficient or not) DMUs does not guarantee positive benefits from the view point of efficiency.

This paper by Singh (2009) offers a sapience into the effectiveness of combinations in the Indian Banking System by examining the effectiveness benefits of less than 10 mergers among many listed marketable banks in India over the period 2000- 2001 till date and anatomized the recent mergers (involving both private and nationalized banks) by using the DEA. They anatomized the profit effectiveness and cost effectiveness of the acquiring bank to see whether there have been earnings from connection and it was found that while the combinations do not impact the cost and profit effectiveness in an adverse manner and whatever loss that happed originally was recovered snappily.

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The effectiveness of M&A among publicly traded companies in Brazil assessed by Junior et al., (2013) and found that the emergence of synergy gains by using models with multiple objectives from Goal Programming and Data Envelopment Analysis (GPDEA) method, using different indicators of accounting as input and output variables. These models enable the analysis and categorization of M&A based on the efficiency attained in these kinds of procedures. When traditional models were applied, a few of the M&A cases under analysis were incorrectly thought to be efficient. Furthermore, the GPDEA was shown to be more successful than classical models, as it was expected. Nevertheless, only a small percentage of the cases examined were found to be successful.

This study used an empirical analysis of 20 M&A transactions in the US commercial banking sector by Rahman et al., (2016) to examine marketing efficiency as a proxy for post-merger performance. Efficiency is measured using Data Envelopment Analysis (DEA), which uses two input variable and two output variables. The findings showed that, despite their tiny impact, M&A transactions do improve the combined companies' marketing effectiveness.

In order to gauge the M&A impact on the financial performance Jena and Sanyal (2024) examined the bank mergers between 2006 and 2018 happened in India. Four Indian banks were chosen as a sample, SBI, Bank of Baroda, HDFC Bank, and Kotak Mahindra Bank and their market capitalization data was taken. Financial performance efficiency was assessed in this paper by comparing five years of pre- merger and post-merger data. Throughout in this research, the writers took into account seven important factors those affecting Indian banks' performance. For measuring efficiency over time, DEA, a non-parametric technique, is employed and the study demonstrates that acquisitions and mergers have a favourable effect on improving financial efficiency.

Objectives of The Study

The objectives of the study is;

- To assess the impact of the merger on the asset management and control on the expenses to maximise operating cash flows and net sales of the acquirer companies (DMUs) in the post-merger time in comparison with the pre-merger time.
- To find out efficient and inefficient companies in the sample data with the present input and output mix.
- To find out the scale of operations before and after the merger.
- To find out the position (Ranking) of the DMUs before and after the merger to judge companies' situation in both the periods.

Methodology and Model Used In The Study

Data Envelopment Analysis (DEA) is a fairly new "data acquainted" non-parametric performance assessment technique to assess the performance of a set of data termed as Decision Making Units (DMUs) which analyse single/multiple inputs with single/multiple outputs. The description of a DMU is general and flexible. The DEA has used a varied range of operations in recent years to evaluate the performances of many different types of realities involved in many different activities in many different settings in many different nations. Efficient DMUs' are assessed using the identical input and output data of varied DMUs. DEA, is first designed by Charnes et al. (1978), constructs an efficient frontier by identifying the best practice DMUs from a common data set. Frontier takes in multiple inputs and provides multiple outputs. The proximity to the frontier determines efficiency. DMUs those are closest to the frontier line are termed as efficient unit and those farther away from the frontier line are inefficient units.

Model of The Study

Various DEA models have been created in the DEA literature since 1978. There are two techniques for this namely, radial and non-radial. Differences exist in the characterisation of inputs and outputs. There are two widely recognised basic DEA models that is CCR model which is called after Charnes, Cooper, and Rhodes, 1978 and the BCC model which is called after Banker, Charnes, and Cooper, 1984. Both of the models are radial measures of efficiency and have two different types those are input-oriented model and output-oriented model. Input-oriented technical model attempts to reduce input quantities as much as feasible while maintaining current level of output, whereas output-oriented technical efficiency aims to maximise output levels using current level of inputs.

Different terminologies used in CCR and BCC Model

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The input-oriented BCC model and the input-oriented CCR model, two of the most well-liked and frequently applied basic DEA models, were used in this study to estimate efficiencies. Pure technical efficiency (PTE) is measured by the BCC model, whereas overall technical efficiency (OTE) is measured by the CCR model. Scale efficiency (SE) is measured by OTE and PTE. SE equals OTE divided by PTE. Therefore, three types of efficiencies namely OTE, PTE, and SE can be found using the CCR and BCC models.

Overall Technical Efficiency or OTE, also known as CCR efficiency, is based on constant returns-to-scale (CRS). This concept measures the inefficiency resulting from an incorrect combination of input-output configuration, encompassing operational and scale inefficiency.

Pure Technical Efficiency or PTE also known as BCC efficiency under the variable returns-to-scale (VRS) where the assumption defines efficiency regardless of operating scale or inefficiency caused by managerial underperformance. Since the VRS frontier is closer to the piecewise boundary locations that are observed to be inefficient PTE, it is always greater than or equal to OTE. A DMU is said to be operating at the maximum productive scale size, or 100% scale efficiency, if it obtains perfect scores (100%) for both the CCR and BCC.

Scale Efficiency (SE) determines whether a DMU is in the appropriate size for operation. It is mainly the link between a company's production cost per unit and output volume. So, scale efficiency (SE) cannot be more than one and is calculated as the CCR score divided by the BCC score.

Mathematical Formulation of CCR and BCC Models:

CCR Model

Assumption has been made that there are n DMUs to evaluate [DMUj (j = 1, 2, 3, 4…., n)]. DMUs [xij (i = 1, 2, 3, 4…., m)] consume m different inputs of identical character, resulting in's' different outputs of identical type for all DMUS [yrj (r = 1, 2, 3, 4..,s)]. Assume xij and yrj are positive (xij > 0 and yrj > 0). Furthermore, each DMU is considered to have at least one positive input and one positive output value. Given the data, the efficiency of DMUb can be measured using the following formulation.

$$\text{Min } \theta_b - \varepsilon \left(\sum_{i=1}^{m} s_i^- + \sum_{I=1}^{s} s_r^+ \right)(\theta, \lambda_j\, si_r^-, s^+)$$

Subject to

$$\sum_{j=1}^{n} x_{ij}\lambda_i + s_i^- = \theta_k\, x_{ib} \quad i = 1, 2, 3, 4\ldots..,m.$$

$$n \sum yrj\, \lambda j - sr + = yrb \; j = 1 \; r = 1, 2, 3, 4\ldots..,s$$

$$\lambda_j \geq 0 \qquad j = 1, 2, 3, 4\ldots..,n$$

$$s_i^-, s_r^+ \geq 0 \text{ for all i and r.}$$

.

Where,

x_{ij} = Amount of input of 'i' utilized by the 'j'th DMU

y_{rj} = Amount of output of 'r' produced by the 'j'th DMU

x_{ib} = Amount of input of 'i' utilized by DMU_b

y_{rb} = Amount of output of 'r' produced by DMU_b

θ_b = efficiency score of DMU 'b' being evaluated

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λs represent the dual variables which identify benchmarks for inefficient units.

Slack variables: s_i^- (input slacks), s_r^+ (output slacks)

ε >0 refers to a non-Archimedean element that is smaller than any real number and can be accommodated without specifying its value.

The input-oriented CCR model (envelopment or dual version) described above is utilised to estimate OTE in this study. The primal and dual DEA programs are relative. Multiplier or Primal DEA programs are those that use input and output weights. The DEA program that involves DMU weights is known as the Envelopment or Dual DEA program.
It is the reverse of the output maximising multiplier program. In the dual form, the maximum number of constraints is limited to the number of inputs and outputs, but in the primal form, the number of constraints is determined by the number of DMUs being assessed.

The mathematical program above calculates the efficiency score (θ) of a specific DMU_b. To obtain the efficiency score of other DMUs, the same procedure must be followed for each DMU, i.e., 'n' optimisations for each DMU_j. DMUs with 1 are inefficient, whereas those with = 1 are efficient and on the frontier line. Some frontier or boundary points may be 'weekly efficient' because they have non-zero slacks in inputs and/or outputs. BCC Model

The BCC model is a significant extension of the CCR concept. It evaluates technical efficiency rather than pure technical efficiency, indicating inefficiency caused by managerial underperformance. The BCC model differs to some extent from the CCR model with an additional constraint in the above mentioned CCR model. This constraint is known as convexity constraint. It evaluates the efficiency under VRS.

$$\sum_{j=1}^{n} \lambda_j = 1$$

A DMU is BCC efficient if the optimal solution of the above two-phase procedure satisfies both the following conditions:

a) θ = 1; and b) All slacks are zero.

DEA Input-Output Variables, Data Collection & Study Period

DEA Input-Output Variables Used

Selection of the input and output variables is the most vital stage to perform/run DEA model. The variables have an impact on the efficiency scores. To put it another way, changing the variables will cause the efficiency scores to vary while keeping the DMUs constant. It is determined by a variety of factors, including the study's objective and the accessibility of the data, among others. In the current study, DEA rankings for 50 DMUs are calculated one at a time using the "Stata 17" application. For the DEA analysis, the input variable is 1) Total Assets, and the two output variables are 1) OCF and 2) Net Sales.

Total Assets: The total assets of a company are defined as the sum of its current and non-current assets as of the last day of the accounting period.

Operating cash flow: The value of operating cash flow is calculated by subtracting all non-cash, non-operating expenses and incomes from the "net profit before tax and extra ordinary items," but before deducting cash inflow or outflow resulting from changes in working capital. Variations in working capital are always factored into the cash flow from operating activities. A rise in working capital results in cash constraints. Thus, when determining net cash from operating activities, an increase in working capital is regarded as a cash outflow. In a similar vein, cash is released whenever working capital drops. Therefore, when determining net cash from operating activities, a decrease in working capital is regarded as an inflow of cash.

Net Sales: Net sales are the total amount of money received from the sale of goods, non-financial services, mining, building, utilities (such as gas, electricity, and water), trading, employment, and after-sale services. It also includes any export income and fiscal benefits received by the companies.

Data Collection & Study Period

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All the input output values are measured in terms of Indian rupees collected from Prowess database in merger and acquisition section from all the companies' merger between 01.04.2013-31.03,2014. Pre-merger input and output data are obtained after averaging five years annual data from the accounting year 2008-2009 to 2012-2013. Post-merger input and output data are obtained after averaging five years annual data from the accounting year 2014-2015 to 2018-2019 and the base year or merger year is considered as 2013-2014 (01.04.2013-31.03,2014) which is considered as zero.

Results and Discussions

DEA efficiency Score analysis:

This section examines and compares the substance of efficiency scores derived using CCR and BCC models before and after the merger. DEA scores are calculated using 'Stata 17' software. Table I illustrates OTE and its two components, PTE and SE, for each of the 50 DMUs. Efficiency scores are calculated to two decimals. According to the table, 23 DMUs experienced efficiency gains and 26 DMUs experienced efficiency declines during the post-merger time in comparison to the pre-merger time, and 1 DMU remained unchanged from a CCR perspective after the merger, indicating that inefficiency increased in the post-merger time due to an incorrect input-output mix.

Table-1: Efficiency Scores and RTS of the Companies

		PRE-MERGER				POST-MERGER			
SRL NO.	DMU	OTE	PTE	SE	RTS	OTE	PTE	SE	RTS
1	A I A Engineering Ltd.	92.10%	92.11%	99.99%	1	97.75%	97.75%	100.00%	1
2	A P L Apollo Tubes Ltd.	85.20%	85.31%	99.87%	1	100.00%	100%	100.00%	0
3	Allcargo Gati Ltd.	41.76%	41.77%	99.98%	1	21.80%	21.80%	99.99%	1
4	Ambuja Cements Ltd.	89.55%	100.00%	89.55%	-1	44.19%	44.19%	100.00%	1
5	Ashok Leyland Ltd.	52.80%	71.09%	74.27%	-1	100.00%	100%	100.00%	-1
6	Aurionpro Solutions Ltd.	38.84%	39.21%	99.06%	1	44.52%	44.52%	99.99%	1
7	Balkrishna Industries Ltd.	83.50%	83.66%	99.81%	-1	100.00%	100%	100.00%	0
8	Bharti Airtel Ltd.	79.80%	100.00%	79.80%	-1	100.00%	100%	100.00%	-1
9	Birla Corporation Ltd.	63.48%	63.55%	99.89%	-1	32.27%	32.27%	100.00%	-1
10	Birlasoft Ltd.	71.16%	71.25%	99.87%	1	73.75%	73.75%	100.00%	1
11	C G Power & Indl. Solutions Ltd.	99.16%	100.00%	99.16%	-1	31.39%	31.39%	99.99%	-1
12	Delta Corp Ltd.	37.71%	37.93%	99.42%	1	42.32%	42.32%	100.00%	1
13	E I D-Parry (India) Ltd.	29.97%	30.24%	99.11%	-1	28.09%	28.09%	100.01%	-1
14	Glenmark Pharmaceuticals Ltd.	43.66%	43.68%	99.95%	1	67.23%	67.23%	100.00%	-1
15	Godrej Agrovet Ltd.	100.00%	100.00%	100.00%	0	91.76%	91.76%	100.00%	-1
16	Granules India Ltd.	70.73%	70.84%	99.84%	1	72.90%	72.90%	100.00%	1
17	Grindwell Norton Ltd.	94.53%	94.58%	99.95%	1	94.82%	94.82%	100.00%	1
18	Hindoostan Mills Ltd.	40.04%	41.57%	96.32%	1	64.03%	64.03%	100.00%	1
19	Hindusthan National Glass & Inds. Ltd.	44.79%	44.91%	99.73%	-1	30.08%	30.08%	99.99%	-1
20	India Cements Ltd.	46.79%	46.91%	99.74%	-1	37.11%	37.11%	99.99%	1
21	J T E K T India Ltd.	76.34%	76.96%	99.19%	-1	93.63%	93.63%	100.00%	1
22	Macrotech Developers Ltd.	14.39%	14.45%	99.58%	1	52.57%	52.57%	100.00%	-1
23	Mahindra Holidays & Resorts India Ltd.	37.64%	37.71%	99.81%	1	27.35%	27.35%	100.01%	1
24	Maruti Suzuki India Ltd.	74.07%	100.00%	74.07%	-1	100.00%	100%	100.00%	0
25	Mphasis Ltd.	100.00%	100.00%	100.00%	0	74.58%	74.58%	100.00%	1
26	P I Industries Ltd.	82.40%	82.42%	99.98%	1	80.48%	80.48%	100.00%	1
27	P V R Inox Ltd.	47.99%	48.10%	99.77%	1	81.45%	81.45%	100.00%	1
28	Peninsula Land Ltd.	39.10%	39.14%	99.90%	1	2.93%	2.93%	99.93%	1
29	Pfizer Ltd.	47.02%	47.04%	99.96%	1	64.96%	64.96%	100.01%	1
30	Polo Queen Indl. & Fintech Ltd.	24.60%	27.60%	89.13%	1	18.15%	18.15%	100.00%	1
31	Polycab India Ltd.	70.20%	78.89%	88.98%	-1	92.65%	92.65%	100.00%	-1
32	Rane (Madras) Ltd.	89.43%	89.65%	99.75%	1	87.65%	87.65%	100.00%	1
33	Reliance Infrastructure Ltd.	23.92%	28.45%	84.08%	-1	19.35%	19.35%	99.99%	-1
34	Restile Ceramics Ltd.	11.92%	13.08%	91.13%	1	22.24%	22.24%	100.02%	1
35	Sandhar Technologies Ltd.	100.00%	100.00%	100.00%	0	100.00%	100%	100.00%	0
36	Simbhaoli Sugars Ltd.	15.50%	15.94%	97.24%	1	16.74%	16.74%	100.02%	1
37	Smiths & Founders (India) Ltd.	36.77%	100.00%	36.77%	1	100.00%	100%	100.00%	1
38	Steel Exchange India Ltd.	64.73%	64.99%	99.60%	-1	39.33%	39.33%	99.99%	1
39	Sunteck Realty Ltd.	9.45%	9.79%	96.53%	1	36.34%	36.34%	99.99%	1
40	Syngene International Ltd.	76.49%	76.72%	99.70%	1	75.76%	75.76%	100.01%	1
41	Tata Consumer Products Ltd.	24.39%	25.56%	95.42%	-1	45.05%	45.05%	99.99%	-1
42	Tata Steel Ltd.	54.29%	67.65%	80.25%	-1	95.30%	95.30%	100.00%	-1
43	Tech Mahindra Ltd.	89.59%	94.20%	95.11%	-1	92.89%	92.89%	100.00%	-1
44	Tilaknagar Industries Ltd.	52.76%	52.91%	99.72%	1	15.92%	15.92%	99.99%	1
45	Tribhovandas Bhimji Zaveri Ltd.	100.00%	100.00%	100.00%	0	60.62%	60.62%	100.00%	1
46	Trident Ltd.	60.73%	61.05%	99.48%	-1	69.41%	69.41%	99.99%	1
47	United Spirits Ltd.	46.50%	47.97%	96.94%	-1	42.59%	42.59%	99.99%	-1
48	Wipro Ltd.	81.05%	100.00%	81.05%	-1	81.97%	81.97%	99.99%	-1
49	Zee Media Corpn. Ltd.	68.99%	69.17%	99.74%	1	50.36%	50.36%	100.00%	1
50	Zydus Lifesciences Ltd.	67.78%	67.78%	100.00%	1	66.86%	66.86%	100.00%	-1

Source: Data collected from Prowess IQ and compiled by the Authors using STATA17 Software

Where, 1= IRS = Increasing Return-to-scale, 0= CRS = Constant Return-to-scale, -1= DRS =Decreasing return-

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to-scale.

Efficient and Inefficient Companies:

The DMUs are divided into two categories using the DEA methodology: efficient (efficiency score = 1 or 100%) DMUs and inefficient (efficiency score < 1) DMUs. Accordingly, based on their CCR and BCC efficiency scores, 50 chosen DMUs are divided into efficient and inefficient categories in this section. Three groups comprise the companies (Table-II). It is discovered that only one company (Sandhar Technologies Ltd.) is completely technical and scale efficient in both pre-merger time and post-merger time. In the pre-merger time Godrej Agrovet Ltd., Mphasis Ltd. & Tribhovandas Zaveri Ltd. are both technical and scale efficient DMUs and DMUs like Ambuja Cements Ltd., Bharti Airtel Ltd., C G Power & Indl. Solutions Ltd., Maruti Suzuki India Ltd., Smiths & Founders (India) Ltd., Wipro Ltd. are found to be technical Efficient but not Scale Efficient.

In the post-merger period APL apollo Tubes Ltd., Ashok Leyland Ltd., Balkrishna Industries Ltd., Bharti Airtel Ltd., Maruti Suzuki India Ltd., Smiths & Founders (India) Ltd. are found as technical and scale efficient DMUs and other 34 DMUs are both technical and scale inefficient.

Table-2: Efficient and Inefficient Companies in Pre and Post Merger

Efficiency	Both in Pre and Post-merger	Only in Pre -merger	Only in Post- merger
Both Technical and Scale Efficient DMUs PTE = SE=1 i.e. OTE=1	1. Sandhar Technologies Ltd.	Godrej Agrovet Ltd. Mphasis Ltd. Tribhovandas Bhimji Zaveri Ltd.	APL apollo Tubes Ltd. Ashok Leyland Ltd. Balkrishna Industries Ltd. Bharti Airtel Ltd. Maruti Suzuki India Ltd. Smiths & Founders (India) Ltd.
Technical Efficient but not Scale Efficient DMUs PTE = 1, SE <1 i.e. OTE < 1	None	Ambuja Cements Ltd. Bharti Airtel Ltd. C G Power & Indl. Solutions Ltd. Maruti Suzuki India Ltd. Smiths & Founders (India) Ltd. Wipro Ltd.	None
Both Technical and Scale Inefficient DMUs OTE<1, PTE < 1, SE <1	34 companies		

Data collected from Prowess IQ and compiled by the Authors using STATA17 Software

Scale Analysis:

In case of several sample companies, scale inefficiency has an impact on overall technical efficiency. The issue of scale inefficiencies is explained by examining the companies' returns-to-scale (RTS) in before and after the merger periods. The details of returns-to-scale is provided in Table III for each of the DMU where it is found that in pre-merger period 26 DMUs are operating in increasing returns to scale, 4 DMUs are operating in constant returns to scale and 20 DMUs are operating in decreasing returns to scale but after the merger 29 DMUs are operating in increasing returns to scale, 4 DMUs are operating in constant returns to scale which is same before the merger and 17 DMUs are operating in decreasing returns to scale. DRS is the primary cause of scale inefficiency in both the pre- merger time and post-merger time. However, the number has reduced in the post-merger time. The reason for such DRS could be unregulated asset management by the companies. As a result, these organisations' greatest option for improving OTE is to make effective use of their assets. The findings show that most DMUs continue to operate at the improper scale even after mergers, though the number has declined in the post-merger period.

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Table-3: DMUs and its Returns-to-Scale during Pre and Post-Merger period

Returns to Scale	Pre-merger	Post-merger
Number of DMUs in IRS	26	29
Number of DMUs in CRS	4	4
Number of DMUs in DRS	20	17
Total	50	50

Source: Data collected from Prowess IQ and compiled by the Authors using STATA17 Software

Where, RTS = Returns-to-scale, IRS (1) = Increasing Returns-to-scale, CRS (0) = Constant Returns-to-scale, DRS (-1) =Decreasing returns-to-scale.

Analysis of Ranking of the DMUs:

Ranking method is a common strategy in DEA. In this study, rankings were based on PTE score. By evaluating the ranking of the selected DMUs shown in table IV, it can be inferred that certain companies that were less efficient before a merger showed improved efficiency after the merger, while others with higher efficiency before the merger experienced a decrease in efficiency afterward. This table also shows that the DMUs with the same PTE received the same rank. For example, during the pre-merger time period, rank 1 was allocated to 10 DMUs based on this approach, and the second ranked DMU was given rank 11 because there were 10 DMUs in rank 1. During the post-merger period, 6 DMUs were assigned rank 1 based on this approach. However, because rank 1 has 6 DMUs, the second-ranked DMU has been assigned rank 7.

Table-4: Ranking of companies Pre and Post the Merger

DMUs	Pre-merger Rank	Post-merger Rank	DMUs	Pre-merger Rank	Post-merger Rank
A I A Engineering Ltd.	13	8	P I Industries Ltd.	17	18
A P L Apollo Tubes Ltd.	15	1	P V R Inox Ltd.	31	17
Allcargo Gati Ltd.	37	45	Peninsula Land Ltd.	40	50
Ambuja Cements Ltd.	1	33	Pfizer Ltd.	33	26
Ashok Leyland Ltd.	22	1	Polo Queen Indl. & Fintech Ltd.	45	47
Aurionpro Solutions Ltd.	39	32	Polycab India Ltd.	18	13
Balkrishna Industries Ltd.	16	1	Rane (Madras) Ltd.	14	15
Bharti Airtel Ltd.	1	7	Reliance Infrastructure Ltd.	44	46
Birla Corporation Ltd.	28	39	Restile Ceramics Ltd.	49	44
Birlasoft Ltd.	21	21	Sandhar Technologies Ltd.	1	1
C G Power & Indl. Solutions Ltd.	1	40	Simbhaoli Sugars Ltd.	47	48
Delta Corp Ltd.	41	35	Smiths & Founders (India) Ltd.	1	1
E I D-Parry (India) Ltd.	43	42	Steel Exchange India Ltd.	27	36
Glenmark Pharmaceuticals Ltd.	36	24	Sunteck Realty Ltd.	50	38
Godrej Agrovet Ltd.	1	14	Syngene International Ltd.	20	19
Granules India Ltd.	23	22	Tata Consumer Products Ltd.	46	31
Grindwell Norton Ltd.	11	10	Tata Steel Ltd.	26	9
Hindoostan Mills Ltd.	38	27	Tech Mahindra Ltd.	12	12
Hindusthan National Glass & Inds. Ltd.	35	41	Tilaknagar Industries Ltd.	30	49
India Cements Ltd.	34	37	Tribhovandas Bhimji Zaveri Ltd.	1	28
J T E K T India Ltd.	19	11	Trident Ltd.	29	23
Macrotech Developers Ltd.	48	29	United Spirits Ltd.	32	34
Mahindra Holidays & Resorts India Ltd.	42	43	Wipro Ltd.	1	16
Maruti Suzuki India Ltd.	1	1	Zee Media Corpn. Ltd.	24	30
Mphasis Ltd.	1	20	Zydus Lifesciences Ltd.	25	25

Source: Data collected from Prowess IQ and compiled by the Authors using STATA17 Software

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Super-efficiency analysis:

Due to inconsistency in the results to allocate specific ranks to the DMUs through STATA Software again the PTE scores were analyzed in another software that is EMS in Table V where specific ranking is allocated to the DMUs in both pre-merger time and post-merger time. It is found that after the merger 22 DMUs improved their efficiency to control their asset management, 4 DMUs remain same in both the pre-merger time and post-merger time and 24 DMUs could not control their asset management after the merger.

Table-5: Ranking of companies before and After the Merger (With Super efficiency)

DMUs	Pre-merger Rank	Post-merger Rank	DMUs	Pre-merger Rank	Post-merger Rank
A I A Engineering Ltd.	8	13	P I Industries Ltd.	18	17
A P L Apollo Tubes Ltd.	4	15	P V R Inox Ltd.	17	31
Allcargo Gati Ltd.	45	37	Peninsula Land Ltd.	50	40
Ambuja Cements Ltd.	33	9	Pfizer Ltd.	26	33
Ashok Leyland Ltd.	7	22	Polo Queen Indl. & Fintech Ltd.	47	45
Aurionpro Solutions Ltd.	32	39	Polycab India Ltd.	13	18
Balkrishna Industries Ltd.	5	16	Rane (Madras) Ltd.	15	14
Bharti Airtel Ltd.	1	1	Reliance Infrastructure Ltd.	46	44
Birla Corporation Ltd.	39	28	Restile Ceramics Ltd.	44	49
Birlasoft Ltd.	21	21	Sandhar Technologies Ltd.	6	10
C G Power & Indl. Solutions Ltd.	40	5	Simbhaoli Sugars Ltd.	48	47
Delta Corp Ltd.	35	41	Smiths & Founders (India) Ltd.	3	2
E I D-Parry (India) Ltd.	42	43	Steel Exchange India Ltd.	36	27
Glenmark Pharmaceuticals Ltd.	24	36	Sunteck Realty Ltd.	38	50
Godrej Agrovet Ltd.	14	4	Syngene International Ltd.	19	20
Granules India Ltd.	22	23	Tata Consumer Products Ltd.	31	46
Grindwell Norton Ltd.	10	11	Tata Steel Ltd.	9	26
Hindoostan Mills Ltd.	27	38	Tech Mahindra Ltd.	12	12
Hindusthan National Glass & Inds. Ltd.	41	35	Tilaknagar Industries Ltd.	49	30
India Cements Ltd.	37	34	Tribhovandas Bhimji Zaveri Ltd.	28	7
J T E K T India Ltd.	11	19	Trident Ltd.	23	29
Macrotech Developers Ltd.	29	48	United Spirits Ltd.	34	32
Mahindra Holidays & Resorts India Ltd.	43	42	Wipro Ltd.	16	8
Maruti Suzuki India Ltd.	2	3	Zee Media Corpn. Ltd.	30	24
Mphasis Ltd.	20	6	Zydus Lifesciences Ltd.	25	25

Source: Data collected from Prowess IQ and compiled by the Authors using EMS Software

Findings of the Study

It is evident that as per OTE i.e., CCR efficiency, 23 DMUs have experienced efficiency gain and 26 DMUs have experienced decline in efficiency during post-merger time as compared to pre-merger time and 1 DMU remain unaltered after the merger which indicates that after the merger inefficiency increases due to wrong input-output mix in post-merger period.

Evident results found from Table: II that number of technical and scale efficient DMUs increases in the post-merger period (6 DMUs) in comparison with pre-merger period (3 DMUs). Scale of operations improved slightly after the merger which is shown in Table: III which depicts improvements in the scale efficiencies.

It is also found from Table: III that most DMUs continue to operate at the improper scale even after mergers, though the number has declined in the post-merger era.

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In the Ranking method after the inconsistent result in the STATA 17 software it is found that some organisations with lower efficiency levels during the pre-merger period had greater efficiency levels in the post-merger period, and vice versa. After inconsistency in the ranking in Table: IV, super-efficiency score is calculated by EMS software which depicts (Table: V) that after the merger 22 DMUs improved their efficiency, i.e., those DMUs control their asset management in efficient manner, position in 4 DMUs remain same in both the pre and post-merger period and 24 DMUs could not control their asset management after the merger.

Overall, it is found that CCR efficiency decreases in post-merger period. Number of efficient companies increases in post-merger period based on their CCR and BCC scores, Scale efficiency increases in post-merger period. Ranking of the individual companies decreases in post-merger period in comparison with pre-merger period.

Limitations of the Study

Key restriction of this study is that it was conducted on using a sample of 50 DMUs from the BSE database that belongs from Indian stock market for a certain accounting year, starting from 1 April 2013 to 31 March 2014. Secondly, more input-output mix/ combinations may provide a broader understanding of the input-oriented result. Consideration of an output-oriented mix can also explain maximisation of net sales and/or OCF.

Scope for Further Research

In this research paper data of acquirer companies that are listed in BSE are analysed. If more data were gathered from different stock exchange over a long time, then results may be much more exploratory and enticing. The output-oriented maximisation theory is not explored here. In the future, if the analysis will conduct on more companies over a longer period in varied database or stock markets, such as the NSE, with diverse input-output mixes then there is an ideal chance to see a variety of findings.

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