

Exploring the Impact of Mergers and Acquisitions on India's Banking Landscape: A Data Envelopment Analysis (DEA) Approach

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ABSTRACT

The objective of this study is to examine the impact of mergers and acquisitions (M&A) on the efficiency of Indian banking institutions, with special attention to the large-scale public sector bank consolidations of 2020. Spanning sixteen years (2007–08 to 2022–23), the study captures the effects of global shocks and domestic reforms shaping the sector. Methodologically, efficiency levels are measured using the Data Envelopment Analysis (DEA) technique, while paired sample t-tests are employed to test the study's hypotheses. A distinctive contribution lies in the inclusion of “cash and balances with the Reserve Bank of India (RBI)” as a novel variable, offering fresh insights into liquidity management and operational efficiency in the post-merger context. The findings reveal a strong positive relationship between M&A activity and enhanced bank efficiency, with marked improvements following the 2020 consolidations. These results underscore the validity of the efficiency or synergy theory and provide meaningful implications for academics, policymakers, regulators, banking professionals, and investors.

Keywords: Mergers and Acquisitions (M&A); Efficiency; Profitability; Financial Performance; Indian Banking

INTRODUCTION

Economic growth in a credit-based country like India depends on a robust and long-lasting banking framework, a central pillar of the broader financial landscape (Demetriades & Andrianova, 2004). There has been an abundance of changes in the Indian's banking landscape since the era of independence, and the reasons can be many, such as technological changes, intense competition, globalization, and more specifically, the initiation of several structural reforms of the banking sector (Rakshit & Bardhan, 2022). The banking sector and financial industry reforms initiated in the 1990s, derived from the proposals outlined in the Narasimham Committee report (Narasimham, 1991; 1998), highlighted the importance of bank consolidation through mergers and acquisitions (M&A). The foremost objective behind these reforms is to raise overall health and financial stability and enhance operational effectiveness to make Indian banks globally recognized and competitive (India Brand Equity Foundation (IBEF), 2022). The above-mentioned reforms constitute an integral component of the wider economic reform strategy aimed at increasing the efficiency and competitiveness of the Indian bank (Poshakwale & Qian, 2011). As a result of such reforms, there has been an increase in M&A transactions in the Indian banking sector, thus contributing towards its establishment as a significant player on the international platform (Roy,

2018). The reforms have increased the stability and security of the Indian banking sector by ensuring that the adequacy of capital is aligned with international norms, and the net NPA issue has been controlled. To achieve an efficient and financially sound banking system in India, M&A has emerged as the best approach, facilitating strategic alliances and enhancing competencies for banks seeking both domestic and international exposure (Singh & Das, 2018; Dutta et al., 2020). M&A is regarded as a key strategy for firms aiming to improve profits, conserve scarce resources, and achieve cost savings (Peyrache, 2013).

Despite the fact that the Narasimham committee advocated the M&A of Indian banks in the 1990s to advance the banking industry, nonetheless, the plan's execution specifically began post-2015 with the Kotak Mahindra and SBI's mergers, followed by the merger of Bank of Baroda and others (Dhameja et al., 2021). Public sector bank mergers are government-driven, while private sector bank mergers are market-driven (Mohan, 2005). The ultimate objective behind this series of PSB mergers was to reduce the level of NPAs as the bad credit situation worsened, with PSBs incurring significant losses totalling more than 16,272.34 crores in 2014-15 (Rathore et al., 2016). The Government of India recognized the need for a series of mergers to boost the efficiency, profitability, and international market strength of public sector banks

(PSBs), which have historically played a central role in the Indian economy, accounting for nearly 60% of commercial bank assets (Kumar, 2013; Reserve Bank of Australia (RBA), 2019). However, PSBs are increasingly losing market share to private banks, which are becoming the nation's primary lenders. Between the end of 2016 and 2021, the outstanding loans of public sector banks increased by Rs. 14.4 trillion (US\$ 180.26 billion), while those of private banks grew by Rs. 22.8 trillion (US\$ 285.41 billion), reflecting a discrepancy of about 60% (IBEF, 2023). The COVID-19 shock and its negative results, which put NPAs in a stressful and concerning situation for the RBI and policymakers, may be the cause of this transition (Goswami, 2022). The worsening asset quality of Indian banks has been exacerbated by the COVID-19 pandemic. In response, the Government of India initiated a fresh wave of mergers in 2020, consolidating 10 public sector banks into 4 institutions to enhance transparency and create globally recognized, efficient major banks for the future. The government, in context to the mega mergers, suggested that "The adoption of best practices across amalgamating entities would enable the banks to improve their cost efficiency and risk management." (PIB, 2019).

2.LITERATURE REVIEW

The effectiveness of banking operations has long been a topic of great importance not only for economic theorists but also for policymakers. Efficiency is a very important aspect in terms of academic and policy circles. As a metric to gauge optimal resource usage, efficiency is an essential element in ensuring that the financial sector continues to develop sustainably. The first investigation into efficiency was made by Farrell (1957) through his study titled "Measurement of Productive Efficiency." The research concentrated on productive efficiency, emphasizing the importance of maximizing output using the available inputs. On the other hand, Debreu (1951) suggested the resource utilization coefficient analysis technique, whereas Koopmans (1951) defined efficiency as a point where inputs and outputs cannot be optimized further without affecting each other. Subsequent studies conducted by Cviliakas & Jurkonyte-Dumbliauskiene (2016), amongst others, highlighted the importance of efficiency through the efficiency relationship between the use of inputs and outputs produced. Efficiency may be analyzed using several approaches, such as TE, SE, cost efficiency, profit efficiency, and allocative efficiency. SE concept was highlighted by Farrell as being the percentage of total efficiency over pure technical efficiency, where the latter refers to the production process at an "optimum" level of input use. In addition, according to Othman et al. (2016), SE refers to the "ideal activity level" where "efficiency loss occurs if activities are not carried out at the 'optimal scale'." TE, on the other hand, is closely connected to managerial efficiency because of the importance of TE in assessing managerial efficiency. Furthermore, TE has even been mentioned as "global efficiency" by Othman et al. (2016), which is indicative of how the utilization of the inputs as against output production has been gauged. In international research regarding efficiency in banks, studies have been conducted in varied situations. For instance, Adhikari et

al. (2023) and Katusiime (2021) carried out their studies on the banks of Nepal and Uganda, respectively. Studies on Latvian and Bangladeshi banks were done by Krumina et al. (2020) and Ara et al. (2021) and Gazi et al. (2021), respectively. Joash and Njangiru (2015) and Daniya et al. (2016) conducted their studies on Kenyan and Nigerian banks, respectively. Furthermore, Pakistan has been studied by Muhammad et al. (2019). M&A in Indian banks and their impact on efficiency have also been researched by several scholars. According to Herwadkar et al. (2022), through the DEA approach, there was an improvement in the efficiency level of Indian banks after the M&A process. On the other hand, according to Das & Kumbhakar (2024), through stochastic frontier analysis of the same case study, there were insignificant improvements in the efficiency level since the efficiency levels had become worse for PSBs. According to Priyadarshi et al. (2022), productivity gains were evident after mergers, while Senger et al. (2021) reported gains in revenue and performance levels. Furthermore, the effect of M&A process on India's financial ecosystem was shown to be positive by Singh and Das (2018). On the other hand, according to Pahuja and Aggarwal (2016), there were no gains in the performance levels after mergers. Mergers in the PSB sector were studied using DEA, MPI, and SFA techniques, revealing an improvement in efficiency owing to productivity brought about by technology improvements despite inefficiency in labor utilization. Another study assessing the effects of State Bank of India's merger with its affiliated banks in 2017 suggested that efficiency had been improved owing to better performance by weaker institutions (Kumar, 2023; Ganesh S & Bhujanga Rao, 2025). An RBI report (2023) further reinforced that bank mergers increased technical efficiency of acquiring banks, rising from 90.88 pre-merger to 94.24 five years post-merger. Complementary studies confirm broader benefits: improved capital adequacy, stability, and competitiveness in PSBs (2023), significant gains in SBI's employee productivity and deposit mobilization post-merger (2023), and positive shifts in capital structure dynamics in merged banks (2023) ((Kaur & Singh, 2023; Chouhan & Singhai, 2025). As a key measure of the government as a catalyst in transforming a dissonant Indian banking landscape, addressing the problem of NPAs, and creating scale-efficient, globally competitive banks through mergers and acquisitions (M&A) (Kumari, 2025). All literature studies show that regulatory nudges, capitalizen strengthening, technologization, and expanding market presence were major drivers, especially around the SBI merger of 2017, as well as the 2019-2020 mega-mergers undertaken by PSBs (Maani & Rajkumar A, 2024). From the methodological point of view, the vast majority of the literature relied on the pre- and post-merger financial ratio analysis techniques of ROA, Non-Parametric Analysis (NPA) ratios like CAR, loan-deposit model, and profitability indicators for important PSB consolidation exercises like the PNB-OBC-UBI merger, the BoB-Vijaya-Dena merger, the Union-Andhra-Corporation merger, the Canara-Syndicate merger, and the Allahabad-Indian Bank merger (Verma et al., 2023; Ganesh S & Bhujanga Rao, 2025). For the most part, these studies indicate that there has been an improvement in the areas

of capital adequacy, asset quality, and market/shareholder wealth gains but the advantages in terms of scale and solvency appear to be more evident than the gains in terms of profitability and operating efficiency (Kumari, 2025). Thus, the reviewed literature supports the formulation of the following hypotheses:
H1: There is no effect of M&A on the Technical Efficiency of Indian banks pre- and post-M&A.
H2: There is no effect of M&A on the Scale Efficiency of Indian banks pre- and post-M&A.

3. RESEARCH METHODOLOGY

The rationale of this study is to explore the efficiency outcomes of Indian banks that underwent M&A during the period from 2007–08 to 2022–23.3. Another goal is to

$$\text{Max } \theta_0 = \frac{\sum_{r=1}^s U_r Y_{r0}}{\sum_{i=1}^m V_i X_{i0}}$$

$$\text{Subject to: } \frac{\sum_{r=1}^s U_r Y_{rj}}{\sum_{i=1}^m V_i X_{ij}} \leq 1 \dots \dots u_r, v_i \geq 0; j = 1 \dots \dots n.$$

The efficiency score of each bank within the reference set $J = 1, \dots, n$, is assessed relative to the performance of other banks within the set. A number of academics have examined the efficiency of Indian banks using the DEA framework due to its recognition as a robust analytical tool (Asmild et al., 2007). For example, Dar et al. (2021) measured the proficiency of Indian banks by keeping NPAs as uncontrolled variables in DEA and identified that PSBs are having more losses compared to private sector banks. Similarly, Maji & Hussain (2021) investigated the reactions of mergers on the technical efficiency (TE) of banks and found a negative influence of consolidation. Another work by Dar et al. (2021) applied DEA comparatively to analyze the TE of banks, observing that efficiency initially declined between 2014 and 2017 but later began to rise. Hafsal et al. (2020) analyzed the efficiency of Indian banks with DEA and declared an efficiency gap of 16.2%, attributing it to rising NPAs of India's banking industry. Kale (2020), measuring TE and productivity of public, private, and foreign banks using DEA post-GFC, concluded that productivity and efficiency declined after the 2008 crisis. Similarly, Goswami et al. (2019) also investigated the efficiency of Indian banks with DEA and reported that TE declined.

3.1 Model Evolution

DEA, widely used for efficiency measurement, is known as the CCR model (Charnes et al., 1978). The CCR model assumes constant returns to scale (CRS), which means output increases proportionally with input (Fethi & Pasiouras, 2010). Later, Banker et al. (1984) extended the model to the BCC model incorporating variable returns to scale (VRS), allowing for scenarios where input increases may result in output changes that are not proportionate (Heffernan, 2005). There is no consensus among researchers regarding the appropriate scale assumption. The CRS model assumes that the bank has attained the optimum scale size. At this stage, the bank attains scale

identify the forces behind M&A decisions. To successfully achieve the purpose, the study has been conducted in two stages. Initially, the DEA model has been applied for measuring the efficiency of merged banks in India. Since DEA is a non-parametric approach, a paired sample t test has been applied further for the testing of hypotheses. Data Envelopment Analysis (DEA), frequently cited in academic literature as the CCR model introduced by Charnes et al. (1978), is a widely recognized approach for evaluating efficiency. It is a performance evaluation and benchmarking tool that develops the efficient production frontier. This model is appropriate for measuring efficiency as it can mix diverse sets of inputs and outputs to assess efficiency (Ahn & Le, 2014). The original model of Charnes et al. (1978) provided the following model:

efficiency (Coelli et al., 1998). There are many factors in the banking sector that hinder the bank from achieving the optimal scale due to imperfect competition, among others. This explains why the CRS assumption does not always represent the reality in practical cases. Many scholars argue that the use of CRS model is appropriate in distinguishing between small and large banks (Thagunna & Poudel, 2013), while other scholars argue that the use of VRS model should be appropriate in developed banking sector because the optimum scale is unknown (Coelli et al., 1998). As opposed to CRS, the VRS approach usually has more efficient banks because the production possibility set in VRS is more restrictive compared to that in CRS. The reality is that the use of both CRS and VRS approaches is often carried out together. Hence, in this study, both CRS and VRS assumptions are used to calculate TE and SE. TE determines how effective the usage of inputs by the banks is in the production of their output. TE is computed through: $TE = (\text{Actual output of the decision-making unit}) / (\text{Optimal output of the decision-making unit})$. When TE is equal to one, efficiency is at its peak. If the TE is below one, then there is inefficiency. SE assists in identifying whether the banking system produces at its optimal level considering its size and potential. SE can be expressed by: $SE = (\text{Optimal Input Level for Current Scale}) / (\text{Actual Input Level})$. Together, TE and SE provide a comprehensive understanding of efficiency differences across merged banks.

3.2 Orientation

The DEA method could be either input-oriented or output-oriented. An input-oriented DEA model tries to address the question, "What proportion of reduction of input amount would lead to an equal reduction in the output amount?" The output-oriented DEA model, on the other hand, aims to address the following question, "What is the proportionate increase of output amount when there is no change in input amounts?" (Titko & Jureviciene, 2014). Generally, the nature of the industry plays a significant role in determining whether input-oriented or output-oriented DEA should be used. The DEA model in the banking sector focuses more on input because the management is in control of input rather than the output.

3.3 Approaches and selection of variables

One of the major areas of dispute within DEA literature is variable selection (Sathye, 2003). Thagunna and Poudel (2013) assert that there are three distinct approaches used in evaluating the efficiency of banks, which include the intermediation approach, production approach, and profitability approach. According to the intermediation theory (Sealey & Lindley, 1977), banks are considered financial intermediaries because of their function as intermediaries between deposits and borrowings. Deposits, capital, cost of interests, and costs of operations or any other expense incurred can be seen as the input, while the output will include loans, investments, and securities. This theory is better suited for evaluating the efficiency of the whole bank rather than looking into its individual elements. On the other hand, production theory

considers banks as services organizations that are efficient due to their functions and operations because of the consideration of physical inputs without interest costs. The intermediation approach has been adopted to be suitable for capturing the banking business operations in the present analysis and has been used in earlier research conducted by Berger & Humphrey (1997) and Casu & Molyneux (2003). Deposits (Goswami et al., 2019; Kale, 2020; Sharma, 2018), capital (Arora, 2014; Bhattacharyya & Pal, 2013), interest expense (Goswami et al., 2019; Sharma, 2018), and cash and balances with the RBI have been selected as input variables. Investments (Kale, 2020), advances (Arora, 2014), interest income (Kumar, 2016), and non-interest income (Sharma, 2018)

Input variables	Deposits (Goswami et al., 2019; Kale, 2020; Sharma, 2018)
	Capital (Arora, 2014; Bhattacharyya & Pal, 2013)
	Interest expenses (Goswami et al., 2019; Sharma, 2018)
	Cash and balances with RBI
Output variables	Investment (Kale, 2020)
	Advances (Arora, 2014)
	Interest Income (Kumar, 2016)
	Non-interest Income (Sharma, 2018)

3.4 Sample size

The size of the sample is justified as per the standards suggested by the DEA literature. As per Cooper et al. (2007), the value of DMU (m) should never be lower than the maximum of $\{x*y, 3(x+y)\}$, where the value of x corresponds to the input variables and that of y corresponds to the output variables. In this case, where the value of x and y is equal to four, the smallest of these two values comes out to be 12, whereas, $3(x+y)$ equals 24. Thus, in this case, the sample size chosen is 44 banks, which is higher than the minimum and has very high discriminatory power. The period used for obtaining data includes the past sixteen years beginning from 2007 to 2023. The data for each merging bank are collected over a period of six years, which include three years prior to merger and another three years post-merger. In total, there are 32 commercial banks prior to mergers and twelve post mergers. Data are sourced from the Reserve Bank of India (RBI) database. This time frame is significant because the GFC of 2007–08 had profound effects on Indian banking, and the subsequent period witnessed major PSB consolidations. Using identical pre- and post-merger windows enables appropriate comparisons.

4. EMPIRICAL FINDINGS AND DISCUSSIONS

4.1 Decomposition of OTE:

The OTE scores can be split into two parts, PTE and SE,

where the PTE considers the managerial performance, and SE considers the suitability of the bank size. The splitting of OTE into different scores helps in identifying the sources of inefficiencies. It is a significant aspect that the measures of OTE enable us to compute the overall inefficiency due to pure technical inefficiency (PTIE) and inefficiency due to the size of the banks, commonly known as scale inefficiency (SIE). Nevertheless, opposite to the OTE, the measures of PTE (also known as TE) independently compute the inefficiency due to managerial underperformance, which is also known as managerial inefficiency—how the banks are managing their input variables. The measure of SE enables the banks to choose the optimum scale of production. Consequently, the efficiency scores obtained from the BCC model are always greater than or like those obtained from the CCR model under the CRS assumption. In the existing literature on DEA, all those banks that achieve 1 or equal to 1 OTE and PTE scores are considered efficient banks, stating that they are operating at an optimal level in managerial performance along with their technical performance.

For analysing both (i.e OTE and PTE), four input variables and four output variables have been employed in the present study. Table 1. represents the efficiency scores of 32 banks before the merger for the first three years.

Table 1. Efficiency score of 32 banks before the merger

First year				Second year			Third year		
DMUs	OTE	PTE	SE	OTE	PTE	SE	OTE	PTE	SE
AB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PNB	0.021	0.051	0.410	0.285	1.000	0.285	0.364	0.377	0.965
OBC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
UBI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CB	0.021	0.174	0.122	1.000	1.000	1.000	0.353	0.515	0.685
SB	0.647	1.000	0.647	1.000	1.000	1.000	1.000	1.000	1.000
UBIA	0.071	0.121	0.584	0.069	0.691	0.100	1.000	1.000	1.000
ANB	0.729	1.000	0.729	1.000	1.000	1.000	0.879	1.000	0.879
Indian bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CB	0.631	1.000	0.631	1.000	1.000	1.000	0.251	0.276	0.908
BOB	0.210	0.236	0.889	0.265	1.000	0.265	0.251	0.276	0.908
VB	0.894	1.000	1.000	0.837	1.000	0.837	1.000	1.000	1.000
DB	1.000	1.000	1.000	1.000	1.000	1.000	0.848	0.879	0.965
SBI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBT	1.000	1.000	1.000	0.919	1.000	0.919	1.000	1.000	1.000
SBM	1.000	1.000	1.000	1.000	1.000	1.000	0.886	0.896	0.988
SBBJ	1.000	1.000	1.000	1.000	1.000	1.000	0.944	0.946	0.998
SBH	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBP	0.443	0.835	0.531	0.785	0.889	0.883	0.736	0.786	0.937
BMB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
KMB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
IVB	1.000	1.000	1.000	1.000	1.000	1.000	0.915	0.998	0.916
SCIB	0.699	0.962	0.726	1.000	1.000	1.000	1.000	1.000	1.000
SBI	0.988	1.000	0.988	1.000	1.000	1.000	0.551	0.601	0.917
SBIN	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBI	0.887	1.000	0.887	1.000	1.000	1.000	1.000	1.000	1.000
BOR	0.462	0.531	0.869	1.000	1.000	1.000	0.925	0.925	1.000
ICICI bank lmtd.	0.586	1.000	0.586	1.000	1.000	1.000	1.000	1.000	1.000
SBI	1.000	1.000	1.000	1.000	1.000	1.000	0.938	1.000	0.938
SBS	0.682	0.707	0.965	0.814	0.859	0.947	0.765	0.844	0.907
HDFC Bank ltd	1.000	1.000	1.000		1.000	1.000	1.000	1.000	1.000
CBP.	0.728	0.993	0.733		1.000	0.882	0.768	0.854	0.899

Source: Author's compilation

Table 1. represent that, Out of all the banks considered, those achieving a score of 1 are categorized as fully efficient, whereas banks with scores below 1 are characterized by technical inefficiency and scale inefficiency. For OTE scores, banks attaining a score of 1 include Allahabad Bank (AB), Oriental Bank of Commerce (OBC), United Bank of India (UBI), Indian Bank, Dena Bank (DB), State Bank of India (SBI), State Bank of Travancore (SBT), State Bank of Bikaner and Jaipur (SBBJ), State Bank of Hyderabad (SBH), Bhartiya Mahila Bank (BMB), Kotak Mahindra Bank (KMB), ING Vysya Bank (IVB), State Bank of Indore (SBIN), SBI, and HDFC Bank. Inefficiency in sixteen banks is caused by low OTE scores. In PTE, twenty-three banks were considered to be efficient since they had perfect scores of 1, implying that they utilize resources efficiently for

maximizing their outputs. However, there were some technical inefficiencies caused by mismanagement or inefficiencies in operations. Scores of VRS TE were higher than CRS TE, suggesting highly efficient managers but lack of scale efficiency, such as in the cases of SB, ANB, VB, SBI, and ICICI Bank. In SE, however, there were seventeen efficient banks with inefficient scale operations. In the second year, there were twenty-four efficient banks from their scores of 1 in PTE. The inefficient banks included UBIA (0.691), SBP (0.889), and SBS (0.859). Twenty-nine banks attained the highest scores in PTE, implying that they had efficient managers. Only seven inefficient banks were observed due to their SE scores. In the third year, there were seventeen efficient banks, compared to fifteen inefficient banks, including thirteen inefficient banks in PTE and fourteen in SE.

Table 2. Efficiency scores of 12 banks post-merger

	First year			Second year			Third year		
DMUs	OTE	PTE	SE	OTE	PTE	SE	OTE	PTE	SE
PNB	0.875	0.875	0.875	0.863	1.000	1.000	0.829	1.000	0.829
CB	1.000	1.000	1.000	1.000	1.000	1.000	0.273	0.672	0.406
UBIA	0.280	0.280	0.677	1.000	1.000	1.000	0.268	0.390	0.687
Indian bank	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
BOB	0.727	0.727	0.991	1.000	1.000	1.000	1.000	1.000	1.000
SBI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kotak Mahindra	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SBI	0.524	0.524	0.790	1.000	1.000	1.000	1.000	1.000	1.000
ICICI bank ltd.	1.000	1.000	1.000	0.554	0.693	0.800	0.912	1.000	0.912
SBI	1.000	1.000	1.000	1.000	1.000	1.000	0.713	0.732	0.975
HDFC Bank ltd	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: Author's compilation

The efficiency rates of the banks following the M&A are shown in Table 2 below. At the beginning, there were eight banks that had the perfect efficiency rate of 1, suggesting that these banks were efficient due to technology and scale. Nevertheless, there were still four banks that were inefficient because of the inappropriate use of inputs. They were Punjab National Bank (0.875), Union Bank of India (0.280), Bank of Baroda (0.727), and State Bank of India (0.524). Union Bank of India is the most inefficient among the banks regarding OTE, PTE, and SE. The same four banks were also inefficient in terms of PTE in VRS because of ineffective management policies, with the OTE and PTE varying from 0.280 to 1. In SE, eight banks were efficient, but the remaining four were inefficient, ranging from 0.677 to 1. As per the outcomes of PTE, the inefficiency level has been exhibited by just one bank, which is ICICI Bank Limited

(0.80). This shows a good managerial efficiency level after the merger of banks. According to SE outcomes, all other banks except ICICI Bank Limited (0.80) became efficient on a scale. As per the analysis in the third year, 7 out of 12 banks have become maximally efficient under the OTE approach, but there were 5 banks that were inefficient due to some issues in terms of technical and scale aspects. There were nine banks, which became maximally efficient under PTE, while 3 banks, including Canara Bank (0.672), Union Bank of India (0.390), and State Bank of India (0.732), proved their inefficiency. SE showed that seven banks were working efficiently, while five other banks, including Punjab National Bank (0.829), Canara Bank (0.406), Union Bank of India (0.687), ICICI Bank Limited (0.912), and State Bank of India (0.975), were facing

Table 3. Average scores pre-M&A

Banks	Average TE (pre-merger)	Avg. SE (pre-merger)
AB	1.000	1.000
PNB	0.476	0.553
OBC	1.000	1.000
UBI	1.000	1.000
CB	0.563	0.602
SB	1.000	0.882
UBIA	0.604	0.561
ANB	1.000	0.869
Indian bank	1.000	1.000
CB	0.759	0.846
BOB	0.504	0.687
VB	1.000	0.946
DB	0.960	0.988
State bank of India	1.000	1.000
SBT	1.000	0.973
State bank of Mysore	0.965	0.996
SBBJ	0.982	0.999
SBH	1.000	1.000

SBP	0.837	0.784
BMB	1.000	1.000
KMB	1.000	1.000
IVB	0.999	0.972
SCIB	0.987	0.909
SBI	0.867	0.968
SBIN	1.000	1.000
SBI	1.000	0.962
BOR	0.819	0.956
ICICI bank lmtl.	1.000	0.862
SBI	1.000	0.979
SBS	0.803	0.940
HDFC Bank ltd	1.000	1.000
CBP.	0.949	0.838

Source: Author's compilation

Table 4. Average scores post-M&A

Banks	Avg. TE (post-merger)	Avg. SE (post-merger)
PNB	0.958	0.901
CB	0.891	0.802
UBIA	0.557	0.788
Indian bank	1.000	1.000
BOB	0.909	0.997
SBI	1.000	1.000
Kotak Mahindra	1.000	1.000
SBI	1.000	1.000
SBI	0.841	0.930
ICICI bank lmtl.	0.898	0.904
SBI	0.911	0.992
HDFC bank	1.000	1.000

Source: Author's compilation

Performance of TE and SE of each bank prior and subsequent to the merger is presented in Table 3 and 4 below. Effects of M&A on the efficiency of banks are illustrated through an analysis of the TE and SE of each bank prior to and following M&A. It can be seen that there has been an appreciable increase in the efficiency of PNB due to merger, as its TE and SE have gone up from 0.476 to 0.958 and 0.553 to 0.901, respectively. The same is true for Canara Bank, which witnessed a remarkable improvement in efficiency due to M&A as its TE and SE increased from 0.563 to 0.891 and 0.602 to 0.802, respectively. In contrast, it can be noted that although Union Bank of India's TE declined from 0.604 to 0.557, its SE improved from 0.561 to 0.788. Notably, there was no change in Indian Bank's efficiency, as its TE and SE scores remained unchanged at 1. Bank of Baroda's TE and SE, however, showed an appreciable improvement post merger from 0.504 and 0.687 to 0.909 and 0.997, respectively. Both State Bank of India and Kotak Mahindra Bank showed high efficiency levels of 1 before and after the merger.

There were positive effects on the efficiency level of the merger between State Bank of India and State Bank of India Commercial and International Bank,

which were reflected in the increase of TE and SE scores from 0.867 and 0.968 to 1. Additionally, there were low negative effects on the efficiency level of the merger between SBI and Indore Bank, as demonstrated by the decrease in TE score from 1 to 0.841, whereas the SE score was unchanged at 0.930. There was an intermediary effect on the score levels from the merger of ICICI Bank Limited, where the TE score decreased from 1 to 0.898 but SE score increased from 0.862 to 0.904. Finally, there was a negative impact of the merger of SBI, as revealed by the fall of TE and SE scores from 1 and 0.979 to 0.911 and 0.992, respectively. In contrast, the merger of HDFC Bank showed no changes in technical and scale efficiencies of 1 before and after the merger.

These findings underscore the nuanced and varied consequences of mergers on bank efficiency, ranging from positive outcomes to minimal negative results or intermediate adjustments based on specific merger dynamics.

For further scrutiny of the results, a paired sample test has been applied (see Table 6 and Table 7.). Initially, normality of data has been checked at 5% level of significance for the application of the t test as presented

Table 5. Test of Normality

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TE_POST	.261	12	.053	.698	12	.162
SE_POST	.316	12	.234	.748	12	.231
TE_PRE	.352	12	.342	.711	12	.342
SE_PRE	.310	12	.141	.755	12	.051

Source: Author's compilation

Table 6. Paired samples statistics

Paired Samples Test								
Paired Differences								
			95% Confidence Interval of the Difference			Sig. (2-tailed)		
	Mean	Std. Deviation	Mean	Lower	Upper	t	df	
Pair 1 TE_PRE - TE_POST	-.07925	.21150	.06106	-.21363	.05513	-1.298	11	.221
Pair 2 SE_PRE - SE_POST	-.09500	.13632	.03935	-.18161	-.00839	-2.414	11	.034

Table 7. Paired samples

red Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	TE_PRE	.8345	12	.22510	.06498
	TE_POST	.9138	12	.12523	.03615
Pair 2	SE_PRE	.8478	12	.18902	.05456
	SE_POST	.9428	12	.07916	.02285

Source: Author's compilation

Considering the paired sample statistics, it becomes evident that the mean value of TE scores improved from 0.8345 to 0.9138, while SE scores also exhibited significant enhancement, increasing from 0.8478 to 0.9428. This further underscores the positive consequences of M&A on bank efficiency Table 5, 6 and 7 . However, a closer examination using the paired samples test reveals that the t-value for TE scores (0.221) is greater than 0.05, hence H_1 is accepted. It suggests that there is no statistically significant change in TE post-M&A. Conversely, for SE scores, the t-value (0.034) is less than 0.05, where H_2 cannot be accepted. It indicates that there is a statistically significant enhancement in SE post-M&A. In summary, it can be concluded that while M&A has positively affected SE, there is no substantial effect on TE among the merged banks.

IMPLICATION

This research calculates the TE and SE scores of Indian banks before and after M&A, contributing to the theory of "efficiency or synergy." According to this theory, M&As aim to achieve synergies—operational, financial, and managerial. Financial synergies are particularly significant, as M&As enable banks to expand in scale or establish internal capital markets, thereby reducing the cost of capital and enhancing efficiency (Berkovich & Narayana, 1993). Apart from this, economists place great importance on the effective utilization of resources in

order to achieve maximum output with minimum wastage. This falls under efficiency theory (Copeland & Weston, 1988). This is because the current study supports this theory by considering the effective use of resources through TE and SE analysis. There are many implications of the current study both practically and theoretically. To begin with, academicians and researchers may consider this study as an important criterion when researching into bank efficiency as well as conducting further studies in the subject area. As far as policy makers are concerned, for example RBI and bankers, the current study can be used when making M&A decisions as evidenced in Bank of Baroda taking over Vijaya Bank and Dena Bank and enhancing its performance (Adthakkar, 2022). Investors are in a better position to find out high performing banks and make investments in them. Financial analysts are able to undertake risk assessment and mergers and acquisitions. Most importantly, society gains insight into the concept of bank efficiency.

5. Limitations and Future Research Directions

Nonetheless, there are certain limitations in this research. First of all, the sample size used in this research is rather limited because only a few instances of M&A practices have been considered for the periods 2007-2008 and 2022-2023. Even though this 16-year period could be deemed sufficiently long, it is still insufficient to assess the long-term impact of mergers. Furthermore, this paper deals with just several selected banks. Concerning the

methodology, DEA technique has been applied to calculate the efficiency score in this research. While DEA can be viewed as an effective tool for conducting research, it lacks SFA's ability to assess productivity. It must be also emphasized that the investigation did not focus on several types of efficiency such as cost, allocative or economic efficiency; it only addressed technical and scale efficiencies. Regarding future research methodology, numerous improvements are possible including, for example, implementation of DEA combined with another technique – Stochastic Frontier Analysis. It may become beneficial to take into account such variables as the size of the loan portfolio and number of employees. One can compare bank efficiency across countries or analyze performance gaps between small and large banks or banks with a low and high profit margin before and after mergers and acquisitions.

CONCLUSION

The study aims to evaluate the impact of mergers and acquisitions (M&A) on Indian banks' efficiency levels. According to the results achieved, a variety of trends may be considered: ranging from noticeable efficiency growth to slight changes in performance, which demonstrates that M&A activities have their distinctive peculiarities. As a rule, it is possible to note that M&A positively affects Indian banks, namely, by contributing to the level of scale efficiency. Meanwhile, technical efficiency enhancement cannot be noted in the presence of M&A significantly. Bank efficiency prior to and after M&A implementation was evaluated using the DEA method, followed by a paired sample t-test analysis. Thus, it is possible to conclude that M&A positively impacts Indian banks' efficiency, but there are some limitations to its effectiveness as well.

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Ethical approval and informed consent statements

This study uses publicly available, secondary data and therefore does not require ethical approval.

Data availability statement

All the data utilized in this paper are publicly available and can be accessed through the Reserve Bank of India's (RBI) website and the official websites of the respective individual banks