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# A Study of Efficiency and Change of Productivity between Public and Private Sector Banks in India by using Data Envelopment Analysis

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**ABSTRACT:** This study examines the analysis of efficiency and compare the productivity change of public and private sector banks in India from 2022-2024. We selected 33 banks as sample from two groups :12 public sector banks (PSB) and 21 private sector banks (PVB) for this study. The research methods applied in this study were Data Envelopment Analysis (DEA), Malmquist Total Productivity, and Paired Sample t-test. The outcomes suggest that: 1) Private sector banks have higher efficiency than public sector banks. 2) change in the productivity of public sector banks is powerfully vulnerable to the technological shift rather than changes in technical efficiency. In this paper, there may have difference in efficiency and productivity of two groups of banks.

**KEYWORDS:** Banks, Efficiency, Productivity, DEA, Malmquist Total Index, Paired t-test

## I. INTRODUCTION

It is believed that strong economic growth and development are contingent upon the advancement of the financial sector. Furthermore, because banks are so important to the financial system, any management crisis would involve a level of financial hardship and societal costs that has never been seen before, which might lead to an economic crisis. Because they direct the money to the most beneficial uses in the economy, banks are extremely important to the growth of an economy (Tsolas and Charles 2015). The 2019 McKinsey Report expressed concern about banks worldwide as growth slows down and emphasised the need to take into account a "suite of radical organic or inorganic moves." In comparing banks in developed and emerging countries, the report found that the former's Return On Tangible Equity (ROTE) decreased from 20% in 2013 to 14.1% in 2018. This decline was primarily caused by digital disruption in emerging countries, whereas in developed countries, banks were able to increase productivity and saw an increase in ROTE from 6.8 to 8.9% during the same time period. Interestingly, the World Bank has identified India as a "Powerhouse in global savings and investment" and predicts that the country's share of global investments will nearly treble by 2030.

In 1978, Charnes et al. introduced a DEA model with a constant return to scale [2], followed by Banker et al.'s model with a variable return to scale [5]. These models are appropriate when all entities operate under optimal size conditions. The non-parametric approach is ideal for ranking bank efficiency (Kamecka 2010, Apergis 2011, Holod and Lewis 2011, Sevcovic [7], Halicka, Brunovsky 2001), while the DEA model identifies sources and levels of inefficiency for inefficient DMUs (Stavarek, Repkova 2011). Classical DEA models, as described by CCR (1978), assume that inputs must be minimized and outputs maximized. This approach has been used by numerous authors, including Casu and Molyneux (2000), Fioderlis Marques (2010), Sevcovic, Halicka, Brunovsky (2001), and Stavarek and Repkova (2011). All these papers used the simple DEA CCR (Constant Returns to Scale also CRS model) and BCC (variable returns to scale, in other literature also VRS) model. Economic efficiency of a bank includes allocative and technical efficiency, which measure the bank's ability to maximize output from limited inputs and optimal output production. Estimating this efficiency requires determining an unknown production frontier. This production frontier is estimated parametrically using SFA and non-parametrically by DEA [6].

There are still issues that have not been covered in the earlier research, according to the findings of the current literature. We made an effort to concentrate on the investigation of banking efficiency and productivity across two



distinct bank types in our study, Banks were divided into two categories : public sector banks (PSB) and private sector banks (PVB). The study's findings should pinpoint India's banking industry's efficiency and productivity issues. Additionally, this study was conducted with the intention of determining the bank's level of competition. Data Envelopment Analysis (DEA) and Malmquist Total Factor methods were utilized in this study.

### 1. Efficiency

Efficiency is the performance criteria that underpins all organisational performance, according to Handed et al (2003). The expected performance is the capacity to generate the highest possible output with the available inputs. Additionally, separating units and prices makes it possible to determine the level of technological efficiency, allocation efficiency and overall efficiency. To determine the reasons behind efficiency, more research on the distribution of inputs and outputs can also be conducted, Budi (2010).

### 2. Productivity

When resources are properly managed and used to their fullest potential in order to achieve the best possible outcomes, this is known as productivity. The degree of productivity will inevitably be impacted by any changes in input and output.

### 3. Data Envelopment Analysis

DEA was initially introduced by Charnes, Cooper, and Rhodes in 1978. Data Envelopment Analysis (DEA) is a nonparametric approach to the development of Linear Programming (LP). With the goal of maximizing efficiency, this method evaluates how well resources (input) are used to produce results(output). Similarly, it is employed to quantify the Decision Making Unit's (DMU) production efficiency empirically.

### 4. Research Framework

DEA serves to assess the efficient use of resources (input) to achieve results (output) whose purpose is to maximize efficiency. In this study, the use of the Thinking Framework as follows:

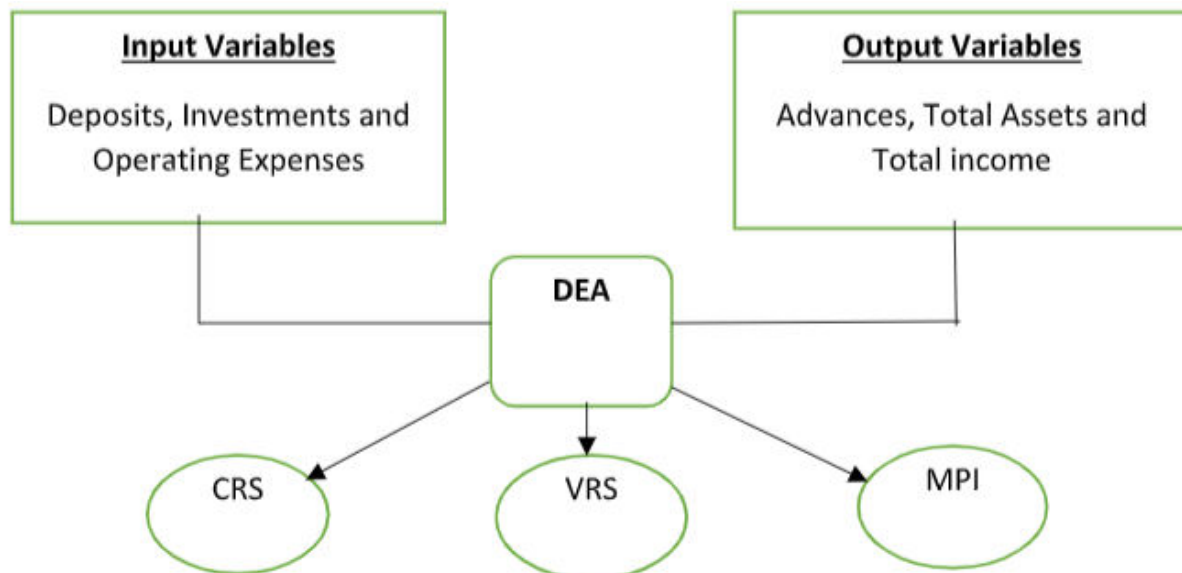


Figure 1. Research Framework Scheme

### 5. Hypothesis

#### Hypothesis for efficiency

Ha1: There is a difference in efficiency between public and private sector banks

#### Hypothesis for Productivity

Ha2: There is a difference in productivity between public and private sector banks.

## Data

The entire research is done using secondary data collected from Indian Banking Association (IBA) for the years 2022-2024.

## II. RESEARCH METHOD

### Data analysis technique

After determining the efficiency and Malmquist total productivity values, we used a paired sample t-test to the significance of the hypotheses. The purpose of this test is to ascertain whether the two related groups differ on average.

#### a) Efficiency Measurement:

As was previously noted, DEA is a technique for determining a DMU's. Efficiency Z, is a ratio between the total amount of outputs to the total amount of inputs and mathematically expressed as:

$$Z = \frac{\text{total amount of output}}{\text{total amount of input}}$$

#### b) Constant Return to Scale (CRS)

A simple variant of the DEA model, the CRS model makes use of the constant return to scale assumption, which has consequences for an efficient linear set. Originally created in 1978 by Charnes, Cooper and Rhode (i.e CCR model), this paradigm presupposes an equal ratio of input to output addition.

#### c) Variable Return to Scale (VRS)

According to this model, the business does not run at an appropriate scale or has not previously done so. Different outcomes will be shown depending on the ratio of input to output (variable return to scale). In other words, the increase in input will not be proportionate to the increase in intake.

#### d) Measurement of the Malmquist Productivity Index

One DEA technique for analysing nonparametric panel data is the Malmquist index. It is frequently employed to detect shifts in a DMU's productivity level. In general, increases in efficiency and technology can be used to determine the index value. When a DMU's Malmquist index has a value greater than one, it indicates that productivity is rising (Increasing Return to Scale)

## III. RESULTS AND DISCUSSION

### 1. Banking Industry Efficiency:

Descriptive statistics information provided in Table 1 and Table 2 exhibits that, on average, the level of technical efficiency of the overall banking industry in India declined from 2022 to 2024.

Table 1. DEA efficiency value of public sector banks (2022-2024)

Efficiency	Min	Max	Mean
CRSTE	0.186	1.000	0.823
VRSTE	0.198	1.000	0.891
SE	0.656	1.000	0.926

Source: author's calculation using DEAP 2.1 software.

Notes: CRS TE: Technical Efficiency, VRS TE: Pure Technical Efficiency, SE: Scale Efficiency

On average, the public sector banks are 82.3% efficient under CRS. This means banks could reduce inputs by 18.7% while maintaining the same output level, 89.1% efficient under VRS and 92.6% efficient under scale efficiency (SE)

Table 2. DEA efficiency value of private sector banks (2022-2024)

Efficiency	Min	Max	Mean
CRSTE	0.222	1.000	0.828
VRSTE	0.333	1.000	0.958
SE	0.222	1.000	0.867

Source: author's calculation using DEAP 2.1 software.

On average, the private sector banks are 82.8% efficient under CRS and 95.8% efficient under VRS and 86.7% efficient under SE.

By referring tables 1 and 2, and it can be concluded that PVB's have higher efficiency than PSB's under CRS, PVB's have higher efficiency than PSB's under VRS but PSB's have higher efficiency than PVB's under SE.

## 2. Banking Industry Productivity:

Productivity analysis was carried out using the Malmquist Index Productivity (MPI) method or widely known as Malmquist Index (MI). The MI parameter regularly used to measure the productivity change of a decision-making unit (DMU).

Table 3: Malmquist Index summary of annual means for Public Sector banks (2022-2024)

Year	effch	techch	pech	sech	tfpch
2023	1.052	1.102	1.028	1.024	1.160
2024	0.962	0.915	0.990	0.971	0.880
mean	1.006	1.004	1.009	0.997	1.011

Source: author's calculation using DEAP 2.1 software

Effch - Efficiency change, techch - Technical efficiency change, pech - Pure efficiency change, sech- Scale efficiency change, tfpch - Total factor productivity change

For the entire study period of public sector banks, the average total factor productivity change was 1.1% ( $1.011 - 1 = 0.011 \times 100$ ). This is due to an increase in the technical change to the extent of 0.4%, pure efficiency changes are to the extent of 0.9% but scale efficiency remained stagnant.

Table 4: Malmquist Index summary of annual means for Private Sector banks (2022-2024)

Year	effch	techch	pech	sech	tfpch
2023	0.511	0.000	0.869	0.588	0.000
2024	2.280	0.409	1.279	1.782	0.933
mean	1.080	0.000	1.054	1.024	0.000

Source: author's calculation using DEAP 2.1 software

For the entire study period of private sector banks, the average total factor productivity change was 0%. This is due to an increase in the pure efficiency to the extent of 5.4%, scale efficiency changes are to the extent of 2.4% but technical change remained stagnant.

The results table 3 and table 4 above, indicates that it can be concluded that public sector banks are more productive than private sector banks. This is because the productivity change in technical efficiency occurred in 2023 while from 2022-2024, there were shifts in the productivity due to technological progress.

## 3. Regression Test Results for Efficiency

A series of regression tests (paired sample t-test) were performed to determine the difference in efficiency and productivity between bank groups in order to address the hypothesis. The results are as follows:

**Table5. Efficiency difference between public and private sector banks (2022-2024)**

	t-stat	sig.
PSB-PVB	0.1191	0.45

Source: author's calculation using excel

Examination results for two bank groups presented in Table 5 above report that the pair is proven to have statistically significant t-stat value at the significance level ( $p\text{-value} > 0.05$ ). In short, the results indicate that bank groups differ in their level of efficiency. Therefore, we accepted  $H_{a1}$ . It was claimed that variations in the input and output conditions of each bank group were the reason for the disparity in the efficiency levels of the bank groups.

#### 4. Regression Test Results for Productivity

After analysing the productivity changes for two bank groups, we conducted paired sample t-tests, the results of which are hidden in the table below.

**Table6. Productivity difference between public and private sector banks (2022-2024)**

	t-stat	sig.
PSB-PVB	1.8484	0.1028

Source: author's calculation using excel.

The regression test results in Table 6 show that there is a difference in the level of productivity between bank groups. This can be inferred from the productivity study results, which were found to be statistically significant at the significance level ( $p > 0.05$ ). Therefore, we accepted  $H_{a2}$ . Regardless of the kind of bank, banks in two groups can be making various attempts to manage efficiency and productivity while developing their technological capabilities.

#### IV. CONCLUSION

Our study's main objective is to study the differences in the level of efficiency and productivity between public and private sector banks in India. It can be concluded that, private banks have higher level of performance than public banks. Minimizing input costs will improve efficiency and coupled with output maximization efforts of both banks.

According to the results, there may have been variations in the efficiency and productivity levels of Indian banks listed between 2022-2024. Regarding productivity, it is recommended that bank management focus more on technological advancements than inefficiencies. It is anticipated that technological evaluation would increase production and operational efficiency, which will ultimately boost banks performance.

As a consequence, Indian banks must encourage technology development and innovation in order to increase production. The results of the paired sample t-test showed that the two bank groups differed in terms of efficiency and production. Efficiency, Productivity and technological innovation together will make the Indian banking sector more competitive.

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