A Bootstrap Analysis of Indian Commercial Bank's Efficiency

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Abstract

In this study, we are trying to examine the bias-corrected efficiency of selected Indian private sector banks. We collect balanced panel data for 5 fiscal years (2019-2023) from 10 private banks operating in India. A bootstrapping VRS output-oriented efficiency model is considered for estimating the bias-corrected bank's efficiency. The study employs the intermediation approach, using deposit, interest expense, and operating expenses as inputs, and investment, advance, and net profit as outputs. The study aims to enhance the existing literature on banking efficiency by identifying and addressing the inefficiencies caused by bias factors. Efficiency estimation dominates the banking literature. However, studies addressing the issue of 'bias' in the banking industry are inadequate. None of the Indian studies has been encountered by the author where the bias-corrected efficiency of the Indian private banks is being gauged. The outcome of this study submits that Indian private sector banks on average estimate bias-corrected efficiency of 97 percent, indicating fine management of the resources by the private banks in India. Among the private banks operating in India, reports indicate that City Union Bank, DCB Bank, Yes Bank, and ICICI Bank are highly efficient.

Keywords: Private Banks, Efficiency, Bootstrapping, Bias-corrected efficiency

1.Introduction

With the advent of globalization, the integrated financial market evolved, but in the twenty-first century, the adaptation of new technology and digitalization in business models changed the concept of market competition. Financial institutions such as Indian private sector banks have achieved remarkable success both domestically and internationally by leveraging modern technology and optimizing various input and output variables. Indian public sector banks (PSBs) are grappling with non-performing assets (NPAs) and traditional banking practices, while their private sector counterparts are rapidly transitioning to robotic banking. This disparity negatively affects the Indian economy, as Indian public sector banks hold the largest market share. The dualistic nature is reflecting on the Indian banking system, i.e., one group of the bank is highly developed with the core banking system and other groups of the bank are still following the traditional banking system. After the 4th industrial revolution, the Indian banking industry vehemently adopted information technology, and due to that, the private sector banks are leading in the Indian financial market. The performance of Indian private sector banks is better than the PSBs. This study needs to set a benchmark for other commercial banks that will assist them in becoming efficient ones. Efficient banks can be models for the Indian banking sector. Many studies examined the performance of Indian commercial banks through various models, and it's found that the majority of Indian PSBs are loss-making organizations. Hence the present study attempts to represent the most efficient bank from private sector banks with unbiased methodological tools (bootstrap analysis). The paper is organised in the following

way: Section I presents a brief of the banking industry in the country; discusses the review of previous studies conducted in the field of banks's efficiency in Section II; the methodological framework of the study is presented in Section III; Section IV highlights the outcome of the study; key findings of the study are summarised in Section V; and lastly, Section VI shows the suggestions in the form of policy prescription and conclusion. V, and lastly, Section VI shows the suggestions in the form of policy prescription and conclusion.

1.1. An overview of banking industry in India

Yadav (2019) categorized the history of Indian banking into three phases. The first phase (1786-1969) is considered the "primary phase of Indian banking". The Second Phase (1969-1991) is featured with nationalization, regularization, and growth in the industry. Lastly, the third Phase (1991 onwards) is characterized by liberalization and its aftermath. With the advent of liberalization, there was a huge change in the Indian banking industry over the last two decades which turned the sector more commercial-oriented. Abdul and Akhtar (2020) mentioned "funding and liquidity are relatively strong features of the Indian banking system as the loans/deposits ratio is under 80 percent and the banks are required to hold large amounts of Indian government bonds. Their access to off-shore funding is constrained by India's just investment-grade sovereign rating. Capital is also adequate in aggregate but some banks, including large PSBs, require core capital." However, from the 2000s onwards digital banking is adopted by the Indian banking industry. Digitization helped banks to reach each and every customer's pocket in the form of debit, credit cards, e-banking, and m-banking.

1.2. An empirical review on Bank's efficiency

It has been observed that there has been a growing interest on the part of researchers in estimating the efficiency of the banking industry over few decades. This section provides a brief discussion on the various studies conducted throughout the globe for estimating the efficiency of the banking sector. Noulas and Ketkar (1996), Bhattacharya et al. (1997), Saha and Ravishankar (2000), Kumbhakar and Sarkar (2003 and 2004), and Sathye (2003) examined the Indian public sector bank's efficiency with the help of stochastic cost frontier and DEA which concludes that before the recession the efficacy is increasing over the period but after the recession and 2014 Indian public sector bank's performance in declining due to that the efficiency level also decreasing in comparison to other banks. Whereas it is observed in a comparative study of Sathye (2003), the foreign bank's efficiency is increasing followed by PSBs of India. Another comparison is done by Mohan and Ray (2003) among foreign banks, PSBs, and old private sector banks found that PSBs are more efficient. Yeh (1996), Akhtar (2010), Paradi (2011), Zhu (2011), Paul (2015), and. Jain (2016) observed the efficiency level in the different banks with different input and output variables which highlight how bank efficiency has an impact on macroeconomic variables of a country including India. Das et al, (2004) concluded the level of efficiency of Indian banks has a direct positive impact on the share market which means the market capitalization efficient bank is increasing.

To sum up, it can be said that most of the research concluded their outcome on the efficiency of PSBs. We did not encounter any investigation that has been done only on the Indian private sector using a bootstrap approach to capture the effect of environmental factors for estimating the efficiency of the banks. Thus, to fill this research gap and provide a benchmark for the entire banking industry in India the present study is framed.

2. Methodological Framework

2.1. Efficiency Assessment Technique

Efficiency is defined by Lovell (1993) as 'comparison between the observed and optimal values of input and output of a firm'. Farell (1957) has further classified efficiency into three categories namely economic,

technical, and allocative efficiency. The chronological development in the concept of Efficiency is depicted in Table1.

Table 1: Chronological development in the concept of Efficiency

Year	Author	Development
1951	Debreu	Measures utilization of resources
1957	Farrell	Classified efficiency into 'technical efficiency', 'allocative efficiency' and 'economic efficiency'.
1978	Cooper Charnes and Rhodes	Developed a model 'Data Envelopment Analysis (DEA) for ascertaining efficiency under the presumption of Constant Return to Scale'. The prime assumption of the model is that operation of the firm is at the most productive scale size.
1979	Bradley and Efron	Proposed a 'data-based simulation method' for statistical inference.
1984	Banker Charnes and Cooper	Based on the assumption of 'Variable Returns to Scale (VRS) wherein each DMU is allowed to exhibit different returns to scale due to different environment'.
1996	Cooper, Thompson and Thrall	Employ "Multiplier" model approaches to data variations in all inputs and all outputs of all the Decision-Making Units
1997	Berger and Humphrey	Marked the importance of Production Approach and Intermediation Approach
2000	Simar and Wison	Bootstrapping in the DEA model

Sources: Literature on Efficiency

2.2. Efficiency Model for the Study

Using multiple inputs and outputs the parametric model are estimating efficiency. Moreover, the non-parametric model minimizes the risk of the functional specification. Thus, the study adopts the non-parametric model (Data Envelopment Analysis) to examine the efficiency of the Indian private banks. Following the assumption of Banker et al., (1984) this study uses the VRS model of DEA.

For gauging the efficiency of the banking industry intermediation and production approach are being used (Singh & Fida, 2015). The production approach is applied in studies made by Sathye (2001), Nael (2004) where they considered banks as a producer of advance, deposits, and services by utilizing recourses like labour and capital. On the other hand, Sealey and Lindley (1977) proposed the intermediation approach, and Mokhtar et al. (2008) and Bhattacharya et al. (1997) applied by considering banks as an intermediary for channelizing the funds from depositors to converting those funds into loans. Following Sealey and Lindley (1977), the study proceeds with the selection of the input and output variables in line with the intermediation approach. Besides, considering the resource constraint in the country, the study aims to examine the maximization of the output and hence an Output-oriented VRS model of efficiency.

Mathematically, the output-oriented model is explained as:

$\theta \max E = \frac{\text{Actual Output (OE)}}{\text{Maximum Output (OE')}}$(where E refers to efficiency)

The efficiency result, however, is associated with bias. To capture the 'bias-corrected efficiency', the bootstrap model developed by Simar and Wison (2000) has been used. In bootstrapping, the data generating process is simulated repeatedly to find out the new estimates from every replication (Efron, 1979, Efron and Tibshirani, 1993, Khan and Gulati, 2018). Further, the resampled estimates imitate the original estimator distribution (Simar and Wilson, 1998). This distribution of resampled estimates can be

worn to acquire the bootstrapped confidence intervals to know whether estimates of efficiency are statistically significant (Fuentes, 2011, Khan and Gulati, 2018).

Bogetoft and Otto (2010) stated that for eliminating the bias, firstly the bias is estimated followed by obtaining a bias-corrected estimate. The bias is estimated as:

Bias ^{k} = EV ($\hat{\theta}^{k}$) – θ^{k}.

But since the distribution of θ^{k} is unknown, EV ($\hat{\theta}^{k}$) cannot be estimated. Applying bootstrap in this condition, θ^{kb} is a bootstrap replica of the estimate of θ^{k}. The bootstrap replica of the bias is:

$$\text{Bias}^{k*} = \frac{1}{B}\sum_{b=1}^{B} \theta^{kb} - \hat{\theta}^{k} = \bar{\theta}^{k*} - \hat{\theta}^{k}$$

Lastly, a bias-corrected estimator of θ^{k} is:

$$\tilde{\theta}^{k} = \hat{\theta}^{k} - \text{bias}^{k*}$$
$$= \hat{\theta}^{k} - \bar{\theta}^{*} + \hat{\theta}^{k}$$
$$= 2\hat{\theta}^{k} - \bar{\theta}^{k*}.$$

2.3. Selection of Input and Output Variables

The selection of the input variables and output variables are based on the extensive literature review of the efficiency of the Indian banking industry. A list of input variables and output variables is presented in Table 2.

Table 2: Input and Output Variables

Input / Output	Variables	Cited in studies made by:
Inputs	Deposit	Joseph C.Paradi (2011), Haiyan Zhu(2011), Jayeeta Paul (2015), Quey-Jen Yeh(1996), Mohammad Hanif Akhtar (2010), Ravi Kumar Jain(2016)
	Interest Expense	Joseph C.Paradi (2011), Haiyan Zhu(2011), Jayeeta Paul (2015), Quey-Jen Yeh(1996), Ravi Kumar Jain (2016)
	Operating Expense	Joseph C.Paradi (2011), Haiyan Zhu(2011), Jayeeta Paul (2015), Quey-Jen Yeh(1996), Mohammad Hanif Akhtar(2010), Ravi Kumar Jain (2016)
Outputs	Investment	Joseph C.Paradi (2011), Haiyan Zhu(2011), Mohammad Hanif Akhtar(2010), Ravi Kumar Jain (2016)
	Advance	Joseph C.Paradi (2011), Haiyan Zhu(2011), Jayeeta Paul (2015), Quey-Jen Yeh(1996), Ravi Kumar Jain (2016)
	Net Profit	Joseph C.Paradi (2011), Haiyan Zhu(2011), Jayeeta Paul (2015), Quey-Jen Yeh (1996), Ravi Kumar Jain (2016)

Source: Literature Review

2.3. Study Period and Data Source

A period of five (5) fiscal years is considered for the present study, i.e., FY 2019 to FY 2023. Secondary data has been collected for the study. The data of the study is accumulated from the annual report of the banks, the website of the Indian bankers association (IBA), and RBI (The Central Bank of India).

2.4. Population and Sample Size

Presently, 22 Indian private sector banks are operating in the country which is the population of the research. 10 banks out of these 22 banks are considered as a sample for the study.

2.5. Sample Technique

Judgmental sampling has been used. Those banks for which data pertaining to the study period is available are considered for the study. Besides, banks whose operation is concentrated to a specific zone of the country are not considered in the study. Moreover, the sample size (n) abides by the thumb rule suggested by Cooper et. al.,(2007).

a. $n \geq m \times s$

b. $n \geq 3 (m + s)$

Where,

m= number of inputs

s= number of outputs

3. Results and Discussion

The descriptive statistics shown in Table 4, 2019 recorded the lowest figure in terms of all the variables while the last year, 2023 recorded the highest figure. The table also highlights that there exists a high deviation of the data throughout the study period. CAGR figure indicates that there is a positive compound annual growth for all variables.

Table 3: Descriptive Statistics

	Inputs Variables			**Outputs Variables**		
Fiscal Year	**Deposit**	**Interest Expense**	**Operating Expense**	**Investment**	**Advance**	**Net Profit**
2015	153439.240	10899.694	4662.417	56708.333	136170.605	3595.291
2016	184615.692	12643.617	5597.268	67298.435	167708.039	3861.000
2017	218811.645	13662.841	6587.966	69704.650	193267.102	3956.525
2018	258927.075	14556.661	7492.284	84535.077	232329.397	3850.575
2019	305514.784	18245.513	31571.207	95972.881	271213.904	4375.889
Average	224261.687	14001.665	11182.228	74843.875	200137.809	3927.856
SD	60043.904	2734.026	11446.977	15432.089	53100.870	283.988
CAGR	18.716	12.426	50.938	13.659	18.577	3.980
Max	305514.784	18245.513	31571.207	95972.881	271213.904	4375.889
Min	153439.240	10899.694	4662.417	56708.333	136170.605	3595.291

Table 4 depicts a comprehensive picture of the VRS 'output-oriented technical efficiency scores' and 'bias-corrected efficiency scores' of the banks for all the years included in the study. The result shows that the efficiency scores of maximum banks throughout the study period were recorded to be 100 percent. Moreover, the banks that did not record 100 percent efficiency such as IndusInd Bank, Kotak Mahindra Bank and Federal Bank in FY 2023, Kotak Mahindra and Federal Bank in FY 2020, Axis Bank and Kotak Mahindra Bank in FY 2021, Federal Bank in 2022, IndusInd, Federal and South Indian Bank in FY 2023 can reach efficiency to an extent of around 85%. So, it's reflecting the private sector banks are operating efficiently by making optimum utilization of their input bundle. Nevertheless, the input and output bundles of the banks are subject to certain environmental and random factors that influence their efficiency score but cannot be captured in the simple VRS model. This phenomenon is reflected in the table as the $\widetilde{\theta}^{k}$. The $\widetilde{\theta}^{k}$ (bias-corrected eff. score) indicates that the private banks operating in India record an

average bias-corrected efficiency of 97 percent. Thus the banks need to maintain their current operational pattern for catching up to the frontier. The table also highlights that deviation of the efficiency scores implies a relatively lower degree of scatteredness of data.

Table 4: Comparison of Efficiency scores with and without Bias-correction

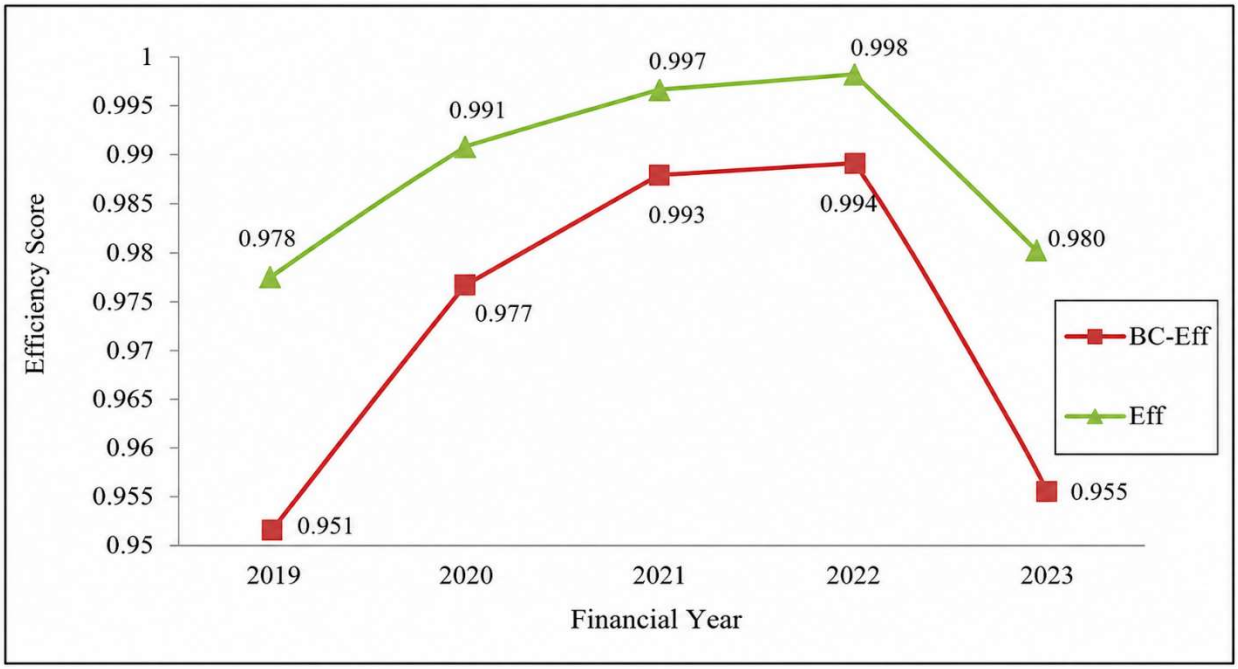
Fiscal Year (FY)	Banks	Eff. Score ($\hat{\theta}^k$)	Bias Corrected Eff. Score ($\tilde{\theta}^k$)	Bias	Bootstrap SD
2019	Axis Bank Ltd.	1	0.977	0.023	0.0003
	DCB Bank Ltd.	1	0.969	0.031	0.0010
	HDFC Bank Ltd.	1	0.970	0.030	0.0009
	ICICI Bank Ltd.	1	0.969	0.031	0.0009
	Indusind Bank Ltd.	0.898	0.880	0.018	0.0003
	Kotak Mahindra Bank Ltd.	0.973	0.955	0.018	0.0002
	YES Bank	1	0.968	0.032	0.0011
	Federal Bank Ltd.	0.912	0.893	0.018	0.0002
	South Indian Bank Ltd.	1	0.965	0.035	0.0010
	City Union Bank Ltd.	1	0.966	0.034	0.0011
2020	Axis Bank Ltd.	1	0.982	0.018	0.0004
	DCB Bank Ltd.	1	0.984	0.016	0.0003
	HDFC Bank Ltd.	1	0.986	0.014	0.0002
	ICICI Bank Ltd.	1	0.983	0.017	0.0003
	Indusind Bank Ltd.	1	0.982	0.018	0.0004
	Kotak Mahindra Bank Ltd.	0.970	0.962	0.008	0.0000
	YES Bank	1	0.986	0.014	0.0002
	Federal Bank Ltd.	0.936	0.927	0.010	0.0000
	South Indian Bank Ltd.	1	0.990	0.010	0.0001
	City Union Bank Ltd.	1	0.984	0.016	0.0003
2021	Axis Bank Ltd.	0.981	0.979	0.002	0.0000
	DCB Bank Ltd.	1	0.995	0.005	0.0000
	HDFC Bank Ltd.	1	0.995	0.005	0.0000
	ICICI Bank Ltd.	1	0.996	0.004	0.0000
	Indusind Bank Ltd.	1	0.994	0.006	0.0000
	Kotak Mahindra Bank Ltd.	0.988	0.985	0.003	0.0000
	YES Bank	1	0.995	0.005	0.0000
	Federal Bank Ltd.	1	0.996	0.004	0.0000
	South Indian Bank Ltd.	1	0.995	0.005	0.0000
	City Union Bank Ltd.	1	0.995	0.005	0.0000
2022	Axis Bank Ltd.	1	0.997	0.003	0.0000
	DCB Bank Ltd.	1	0.997	0.003	0.0000
	HDFC Bank Ltd.	1	0.995	0.005	0.0001
	ICICI Bank Ltd.	1	0.996	0.004	0.0000
	Indusind Bank Ltd.	1	0.996	0.004	0.0000
	Kotak Mahindra Bank Ltd.	1	0.996	0.004	0.0000
	YES Bank	1	0.997	0.003	0.0000

	Federal Bank Ltd.	0.976	0.975	0.002	0.0000
	South Indian Bank Ltd.	1	0.995	0.005	0.0001
	City Union Bank Ltd.	1	0.997	0.003	0.0000
2023	Axis Bank Ltd.	1	0.971	0.029	0.0010
	DCB Bank Ltd.	1	0.975	0.025	0.0010
	HDFC Bank Ltd.	1	0.966	0.034	0.0018
	ICICI Bank Ltd.	1	0.973	0.027	0.0010
	Indusind Bank Ltd.	0.986	0.971	0.014	0.0001
	Kotak Mahindra Bank Ltd.	1	0.970	0.030	0.0010
	YES Bank	1	0.970	0.030	0.0014
	Federal Bank Ltd.	0.949	0.936	0.013	0.0001
	South Indian Bank Ltd.	0.864	0.849	0.015	0.0001
	City Union Bank Ltd.	1	0.972	0.028	0.0012
Average		0.989	0.974	0.015	0.0003

Source: Own Computation using R 64 3.0

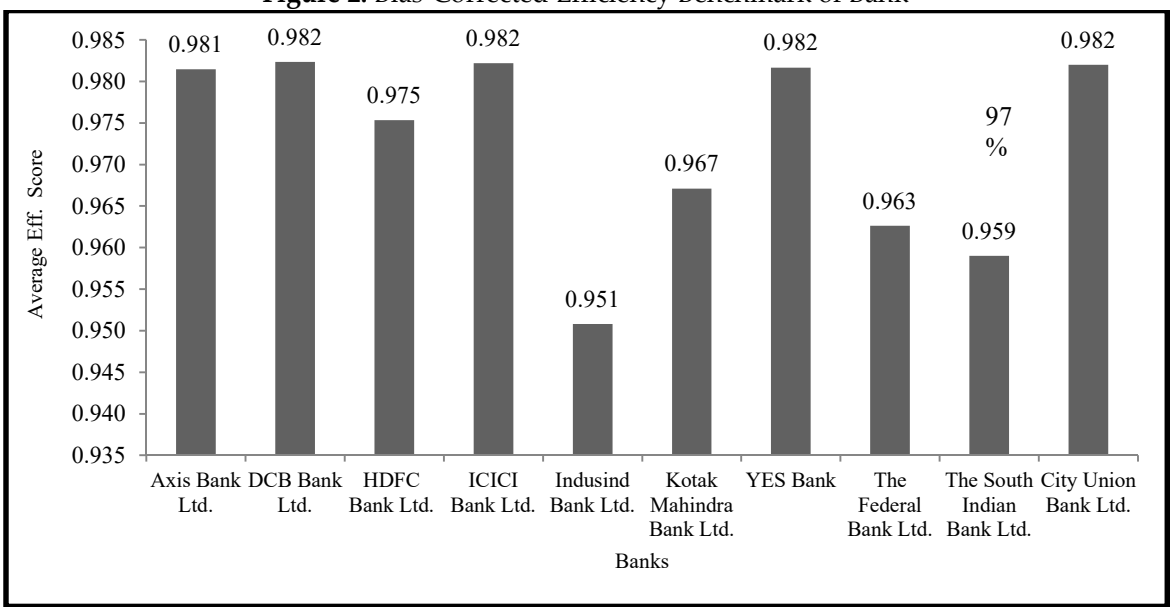
The year-wise trend of the movement of efficiency scores with and without bias-correction is presented in Figure 1. It is depicted in the Figure that both the curves have a uniform trend throughout the study period with a rise till FY 2022. The fall in efficiency scores from FY 2022 to FY 2023 can be because of the bad loan problem of the PSBs that had a spill-over effect in terms of public perception on Indian private sector banks. In the efficiency score, the highest variation without bias-correction and technical score with bias-correction is observed in the FY 2019, FY 2020, and in FY 2023 which signifies that besides the variables considered in the study as input and output bundle, the environmental variables in those periods influenced the efficiency scores.

Figure 1: Trend of Efficiency Score



The benchmarking of the efficiency scores estimated for the banks is represented in Figure 2 and it's found that 97% average bias-corrected efficiency. Out of 10 banks, 6 banks estimated bias-corrected efficiency score above the average. However, bias-corrected efficiency score of 4 banks (Indusind Bank, Federal Bank, South Indian Bank and Kotak Mahindra Bank), remains below the average bias-corrected efficiency.

Figure 2: Bias-Corrected Efficiency Benchmark of Bank



Source: Own computation using MS Excel

City Union Bank, DCB Bank, Yes Bank, and ICICI Bank are the top-ranked private banks based on their efficiency. Banks that estimated efficiency below the benchmark should follow the operations of the top-ranked banks for upgrading their efficiency.

City Union Bank, DCB Bank, Yes Bank, and ICICI Bank are the top-ranked private banks based on their efficiency. Banks that estimated efficiency below the benchmark should follow the operations of the top-ranked banks for upgrading their efficiency.

4. Summary of Findings

The result of the study implies that private sector banks are capable to achieve 97 percent of the production frontier after taking into consideration the environmental bias factor. Further, the study reflected that the sharp fall in the efficiency from FY 2022 to FY 2023 is related to the bad loan problem suffered by the PSBs in FY 2022 to a certain extent. The study also submits that use of bootstrapping for simulation of the data generation process is a much reliable and accurate model for estimation of efficiency. Banks like City Union Bank, DCB Bank, Yes Bank, and ICICI Bank recorded the most efficient private banks operating in India.

5. Policy Prescription and Conclusion

In a developing nation like India considered banking sector is the backbone of the Indian economy. Results of the study denote that the private sector bank records a bias-corrected efficiency score of around 97 percent which indicates a pretty sound state of affairs in terms of efficiency. However, operational practices of DCB Bank, City Union Bank, Yes Bank, and ICICI Bank can be considered as a benchmark by the other private sector banks to achieve the frontier of efficiency.

Besides, the NPA issues and less amount of Non-Performing Asset recorded by the Indian PSBs of Rs. 7.27 trillion (Thakur, 2020) sets an alarming need for adopting a change in their operational mechanism.

Therefore, the operational practice of the private banks, particularly those of the highly efficient once, could be considered by the PSBs too for upgrading their performance.

Nonetheless, determination of the environmental variables that affect the efficiency of the banks remains a potential study area. Besides, a study on efficiency should be paralleled with a study on productivity. Thus, these uncovered areas open another potential study around the area of the present study.

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