Financial Inclusion and Bank Efficiency: Evidence from Data Envelopment Analysis

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Abstract

The issue of low financial inclusion in developing countries is an existing reality which needs to be improved. The present study focuses on evaluating the bank efficiency of India's major drivers of financial inclusion, i.e., public and private sector banks, in fulfilling their task of financial inclusion. The time period considered is 2009/2010 to 2019/2020. A comparative evaluation of the role played by public and private sector banks in financial inclusion initiatives is measured on technical grounds using Data Envelopment Analysis. The Technical Efficiency scores conclude that the private banks are technically more efficient than the public sector in fulfilling this task. The public sector lags behind due to inefficient input utilization and they can improve their efficiency by switching to tech-based services like kiosk banking and internet banking, and jointly promoting financial inclusion with private banks in order to improve their efficiency and save on their input resources.

*Keywords***:** Financial Inclusion, Data Envelopment Analysis, Technical Efficiency, Managerial Efficiency, Scale Efficiency

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Introduction

Financial inclusion (FI) is described as the easy and affordable access to basic banking facilities. However a significant proportion of people in the world are deprived of such basic financial facilities, especially in poverty-stricken developing countries. For a better economic growth, a large percentage of people's participation in the formal financial system is required (Maity & Sahu, 2017). The banking sector has a primary role in the growth and economic development of a society (JishaJoseph & Varghese, 2014). This sector plays the prime role in providing a formal financial platform to common people (Ravikumar, 2013; Maity & Sahu, 2018a). Banks promote a culture of savings among individuals and perform various other activities that contribute to FI (Rao, 2013). Some such activities are providing easy and affordable access to services like savings and short term credit for weaker social groups (Agarwala et al., 2022). Such affordable opportunities can strengthen the position of these groups in society and enable social inclusion as well. Recently, FI has also emerged as a key strategy in enhancing economic activities for overall financial development (Amatus & Alireza, 2015).

Banks allow individuals to save their money by opening an account, provide debit and credit facilities, earn interest on their savings, easy payment and remittance, insurance options and facilitate various government payments like subsidies, direct transfers, etc. (Maity & Sahu, 2018b). However, there is a large segment which remains excluded from formal banking system, commonly known as unbanked masses. Only a formal financial setup can uplift the financial status of these unbanked masses (Ananth & Oncu, 2013). The unbanked class is provided various basic facilities under FI schemes which include: allowing disadvantaged people to open no-frills accounts (no-frills A/Cs)/zero balance accounts, easy and inexpensive payment facilities, specially designed affordable insurance and loan products for the economically weaker class, etc. (Archana, 2013). The reliance of unbanked masses for credit on informal money lenders who lend on high interest may land them in financially vulnerable situations. Therefore in India, Reserve Bank of India (RBI) suggests that 40% of bank credit should go for priority sector lending (PSL) that includes loans provided to the agricultural sector, Micro, Small, and Medium Enterprises (MSMEs), affordable housing, social infrastructure, etc.

The reason behind reluctance of the vulnerable groups to participate in the formal financial system is lack of financial awareness or the widespread financial illiteracy (Maity, 2019). The formal system needs to educate unbanked masses on financial literacy for a better inclusive growth (Pant, 2016; Iqbal & Sami, 2017).

The participation of these vulnerable groups in formal banking system will lead to poverty alleviation, upgradation in their standard of living and overall economic development (Raman, 2012). Such banking reforms play a crucial role in bridging the gap between the privileged and the vulnerable within a society (Iqbal & Sami, 2017). Therefore, the banking sector provides opportunities to create a financially inclusive society to attain social and economic development.

On a historic note, in relation to the Indian context, initiatives taken by the RBI to speed up the FI drive includes: introduction of Lead Bank Schemes (1969) to promote PSL i.e., lending to weaker sections, setting up of Regional Rural Banks (RRBs) on the recommendation of Narsimhan Committee (in 1975), Self Help Groups (SHGs) bank linkage program in 1992, launch of Micro-finance Institutions (MFIs) in 2006 etc. The Indian banking industry includes Public Sector Banks (PSBs), Private Sector Banks (PVBs), RRBs, Foreign Banks and Small Finance Banks (SFBs). However, it is majorly dominated by PSBs (government owned) and PVBs (privately owned), which carry out the major banking activities and are the major drivers of FI initiatives. The PSBs and PVBs together hold around 90% of banking activities relating to credits and deposits, followed by Foreign Banks (5%), RRBs (4%) and SFBs (1%). In the increasingly competitive environment of the financial services industry, the odds of survival will be higher for the banks with higher efficiency than for those with lower efficiency (Tamatam et al., 2019). Moreover, poor efficiency can lead to substantial unfavourable outcomes. The banks are judged on their efficiency in the task of FI. Efficient banks are better at providing basic banking facilities and have a better customer reach. As a result, they also become better at achieving the task of FI. (Maity, 2020).

The core reason behind conducting this study is the existing financially vulnerable class. From a global perspective, 1.6 billion people belong to the unbanked population, for 40% MSMEs, obtaining finance for their businesses from a formal financial set-up is a challenging task, and, 200 million MSMEs have zero access to formal banking facilities (Ernst & Young, 2017). Hence, the study focuses on the role played by PSBs and PVBs towards implementing FI initiatives. The following objectives are primarily focused on understanding and evaluating the overall efficiency. The proposed first objective is to analyze technical efficiency of Indian banks in implementing FI initiatives and the second objective is to examine the comparative role of public and private sector banks in FI initiatives in India. The paper is split into six sections, with introduction, review of literature, research methodology, analysis and findings, discussion, and conclusion.

Review of Literature

Several studies have explored the topic 'efficiency of the banking sector towards achieving FI' in relation to parameters of FI, and techniques utilized for measurement of such parameters. A study by Shihadeh and Liu (2019) presents global evidence indicating that enhancing FI could help banks to achieve more return and decrease risk. Ernst and Young (2017) states that around 21% of the world population is unbanked and that low cost banking solutions can bring them in the ambit of formal financial circle and ensure their financial stability. Chauvet and Jacolin (2017) finds that FI has a positive impact on firms' growth and more competitive banks favour high level of FI. Vo and Nguyen (2021), in a study which used a sample of 1507 banks considering the period 2008–2017, states that in the Asian region, FI plays a significant role in providing a positive contribution to banks' performance. Similarly, Shihadeh et al. (2018) in a study from 2009 to 2014 using a sample of 13 Jordanian banks finds a positive impact of FI on banks' performance. Therefore, banks should devote more resources to increase FI.

Using data from 31 Asian countries, Le et al. (2019) examined the trend of FI and its impact on financial efficiency. There is limited empirical work that provides linkage between financial stability and FI (Cull et al., 2012; Sakarombe, 2018). The question arises whether banks' efficiency impacts FI and supports to alleviate poverty. For this, Marcelin et al. (2021) indicates that depositor accounts and availability of Automated Teller Machines (ATMs) positively impact banks' performance. Dhar (2015) has examined various aspects relating to electronic banking such as ATM, internet and mobile banking, electronic funds transfer system like real-time gross settlement (RTGS), and, electronic clearing services to get an idea on the overall improvement in banks' performance. Similarly, Dangi and Kumar (2013) have suggested electronic and mobile banking as tools for effective promotion of FI initiatives.

Further, delivery channels play the prime role in establishing a connection between the excluded class and the formal financial system (Maity & Sahu, 2019a), therefore, Dhar (2012) analyzes the impact of FI from a micro perspective on five banks namely SBI, Syndicate Bank, UCO Bank, ICICI Bank, and, HDFC Bank. Further, Porkodi and Aravazhi (2013) conducted a study on MFIs and SHGs regarding FI in different rural regions of India. Similarly, Mukherjee and Chakraborty (2012) have studied the productive role of institutions like cooperatives, RRBs, Non-Govt. Organizations (NGOs), SHGs and MFIs in providing assistance in promoting FI programme in Jharkhand. Moreover, studies

like Maity and Sahu (2020) have strived to examine PSBs' efficiency in enhancing FI. Maity and Sahu (2017) measure performance of SBI and associates for 2011-2016 with output variables including deposits and advance as FI parameters (Saha & Ravisankar, 2000). Tyagarajan (1975) Subrahmanyam (1993) and Maity et al. (2020) have examined various issues relating to performance of Indian banks. Dhar (2012) and Maity and Sahu (2018b) analyse the performance of a few selected banks in the area of FI. Different studies have examined the impact of FI on banks' profitability, including Al-Chahadah et al. (2020) which examined Jordanian banks; Issaka Jajah et al. (2020) on banks' of Sub-Saharan Africa; and the study by Ditta and Saputra (2020) which was conducted on Indonesian banks.

Different methodologies have been used by the researchers to calculate the relationships between the banking sector, FI and economic growth. Michael and Sharon (2014) have used correlation and time-series regression analysis to measure FI in Nigeria. Iqbal and Sami (2017) have studied how impactful FI is in the economic growth of the country. These researchers run a multiple regression and the result reflects a high positive relation between dependent variable - Gross Domestic Product (GDP) and the independent FI parameters (number of bank branches and credit-deposit ratio), while a negative relationship is identified between GDP and the ATM growth. Gupta and Singh (2013) have tried to analyze whether the literacy rate within the states has any impact on FI. Kumar and Mishra (2011) have attempted to measure the progress of FI in different states of India based on supply and demand mechanisms. They have calculated FI index for both formal and informal sources of the demand side. In another study, Maity and Sahu (2021a) have measured the FI status of Assam, a north-eastern region state, and compared it with overall India.

To check the relativity of FI indicators, Bagli and Dutta (2012) have used the Principal Component Analysis (PCA) technique. They consider for the study indicators that includ per capita domestic savings, per capita loan outstanding, number of credit and deposit accounts per hundred of the population, number of banks, number of SHGs, credit-deposit ratio, etc. Lakshmi and Visalakshmi (2013) have tried to evaluate the extent of FI based on credit flow to small borrowers in the economy through cooperative banks. They have considered Technical Efficiency (TE) score for analyzing the performance. In addition, Sinha (2009) has analyzed the performance of banks using slacks based measure model. For performance analysis, the researchers of this study, has measured TE using the Data Envelopment Analysis (DEA) technique. The study has considered deposits

mobilized and net worth as inputs and direct advances to agricultural sector and weaker sections as outputs.

Further, Baidya and Mitra (2012) have measured TE of twenty-six PSBs for the year 2008/2009 to 2009/2010 using DEA and found that banks using physical labour to provide customer service were the most inefficient ones. Similarly, Baidya (2012) has evaluated TE using the CCR (Charnes, Cooper & Rhodes) model under the DEA methodology using 30 banks for the period from 2009 to 2011 by incorporating variables of operational efficiency which include: deposits mobilized, off-balance sheet activities, cost management and fund conversion. Moreover, Bhatia and Mahendru (2015) have conducted an analysis on PSBs' TE using the DEA model. They try to examine the efficiency of reformatory and post-reformatory periods. They have run Tobit regression analysis and have found that there exists a negative relationship between the ratio of non-performing assets to net advances and efficiency, and between the ratio of total investments to total assets and efficiency. Further, Gulati (2011) has used DEA to measure TE and concludes that overall managerial inefficiency is the reason for overall technical inefficiency (OTIE). Furthermore, Kumar and Gulati (2008) too examined the TE, pure technical efficiency (PTE) and scale efficiency (SE) of twenty-seven PSB banks. In their second stage analysis they have used logistic regression which identified that the environmental factors were unable to create any significant impact on the TE of banks, hence, falsifying the statement that larger the asset size of banks, higher would be its efficiency.

A study by Nthambi (2015) recommended that banks should take an active role on FI as it supports the profit motive. According to Kumar et al. (2021), branch contraction reduces profitability, and further, loan accounts and ATMs do not affect profitability of a bank. Kumar and Gulati (2008) conclude that higher asset size does not improve efficiency. Further, Rao and Baza (2017) run a regression analysis to study the relationship between financial exclusion and barriers to inclusion which includes cost barrier, credit barrier and low income. They have found that lack of money is the only major reason behind the exclusion among the excluded class of Ethiopia. However, Pant (2016) found that problems such as low financial literacy, inadequate infrastructure and lack of technology-based banking are the biggest underlying causes of exclusion in Nepal.

Mazumdar (2019) states that fulfillment of social objectives as a compulsion of PSBs turns out to be the core reason behind their inefficiency. Similarly, Khatri

(2004) claims that PSBs being government owned, are compelled to fulfill social obligations like opening their branches even in non-profitable rural regions, due to which, they fall behind PVBs and foreign banks in tems of efficiency. Further, Zhao et al., (2008) claim that high PSL loans increase bad loans, creating credit risk for the PSBs, eventually leading to their inefficient performance. Whereas, Mohan and Ray (2004) find no significant difference in performance of PSBs and PVBs, Bhatia and Mahendru (2015), Kumar et al. (2016), Sinha (2009), Paramasivan and Kamaraj (2015) and Dash and Charles (2009) argue that PSBs are better performers than PVBs when the matter is about promoting FI.

The current study focuses on evaluating performance with regards to technical efficiency of the banks in respect of FI. The TE scores help to determine how efficiently the banks have functioned in the FI drive. Banks' efficiency explains the level of competency (expertise in the field) and capability of efficient resource utilization in the FI activity. Higher scores represent that the banks have performed with higher level of efficiency in their task of finanacial inclusion. Kumar and Gulati (2008), Baidya and Mitra (2012), Baidya (2012), Gulati (2011), Bhatia and Mahendru (2015) and Davidovic et.al. (2019) following a similar pattern, have used DEA's efficiency scores to judge banks' efficiency level.

Several drawbacks in the available literature reveals that there is enough scope for further studies on this topic. For example, most of the studies have analyzed performance of banks considering the revenue aspect. The revenue generated is used as a parameter to calculate the efficiency as well as profitability of the banks. Largely the common parameters considered for the analysis includes deposit and credit mobilization. However, the exclusion of core financial literacy data such as people attending financial literacy camps is one of the major problems that the researchers came across while studying the literature. Further, the total amount of loans distributed to borrowers even includes loans offered to big businessmen, corporates, banks, real estate firms, etc. The loans offered to such business houses does not serve the purpose of FI. Only the loans provided under PSL scheme serve the purpose as those loan products are designed to cater to the needs of the target group. A very limited amount of work has been performed by incorporating output variables which can strogly reflect the status of FI like 'people benefitted from financial literacy camps' and 'loans and advances under PSL' for analysing the TE under the DEA methodology. Hence, this study emphasizes on the above mentioned research gap and carries out a comparative analysis between PSBs and PVBs as they are the major players in the banking sector and together hold around 90% of

banking activities relating to credits and deposits. Further, it can be interesting to evaluate the difference between the efficiency level of government owned and private owned banks where an analysis can be made on their economies of scale and to conclude which set-up works better, and which one needs improvement just for strengthening the FI process.

The analysis is based on variables like number of branches which clearly represents the geographic and demographic penetration i.e., outreach of such formal financial institutions among the masses making it a clear indicator of FI. The number of off-site ATMs also taken into consideration. Since the on-site ATMs are located in the branch premises and the bank-branch data is already considered as an input variable, the data on off-site ATMs is used for a better understanding of ATM penetration as they are stand alone ATMs, i.e., people are able to use banking services even if there are no branches of a bank. The asset size as an input variable directly represents the bank size. It is used as a substitute for capital input which facilitates output services and helps in earning revenue and a branch's scale of operations also depends on asset size. The data on the number of employees can represent the extent of customer reach, because when more employees are present, they can tackle more customers with improved service availability. Such variables can provide us with a clear and authentic view about the status of FI.

Based on the research gap and objectives, researchers have set the following two hypotheses. The first alternate hypothesis (H_1) is that there is a significant role played by banks in implementing the FI initiatives and the second alternate hypothesis (H_2) is that there is a significant difference between the technical efficiency of the public and private sector banks in implementing FI initiatives.

Research Methodology

The research design in the present study is based on positivism where the objective reality is scientifically verified using quantified data following a deductive approach and applying mathematical proof. In other words, the objective reality i.e., whether there exists a significant difference between the technical efficiency of the two groups is analyzed following a deductive approach where hypotheses are developed. Further, the developed hypotheses are verified using quantified data where the efficiency of the 16 DMUs are quantified using seven variables (input and output) carrying quantitative data. For a scientific verification of the hypotheses, a mathematical proof has been applied using the DEA methodology.

Sample Design and Data Collection

The data considered for this study has been collected from secondary sources. The secondary data sourced from RBI's database on Indian economy, annual reports of banks included in the sample and various committee reports on the relevant topic are considered for the study.

In this study, a comparative evaluation of PSBs and PVBs in the field of FI is carried out. As of March 2020, there was a total 18 PSBs and 22 PVBs in India. In this study, 16 banks are considered out of which 8 are PSBs and 8 are PVBs. These 16 banks hold around 70% of the market share in terms of deposits and credits among all the PSBs and PVBs (total 40 banks) and hence, are the top players in the field of banking. Further, these 16 banks have the data for the required variables (output) of FI considered in this study.

For this research, the selected study period is of 11 years starting from 2009/2010 to 2019/2020. This fairly long study period has been considered to preserve the authenticity and reliability of the data set. The major reason behind selecting the above stated study period is the unavailability of data prior to 2009; because the initiative taken up by the banks to set up financial literacy camps (FLCs) and the emphasis on financial literacy drive itself started after the year 2007.

Description of Variables

The variables selected for the study are based on their relevance to measure efficiency of the banks in relation to FI. The variables are selected after a detailed review work so that a true reflection of FI can be obtained. In total, the study considers four input and three output variables.

Input Variables
Number of branches. This reflects the geographic and demographic penetration of the banking sector. It clearly represents the outreach of such formal financial institutions among the masses which makes it a clear indicator of FI. An increase in number of branches directly maximizes the bank's business operations and volume of transactions. In multiple studies such as Chatterjee and Sinha (2006), Maity (2020), Iqbal and Sami (2017), Maity and Sahu (2018b), and, Khatri (2004), the number of branches is considered as an input variable.

Number of ATMs. A better ATM service represents a better availability of banking facilities. This also reflects the geographical and demographic penetration and

hence makes it a FI indicator. Maity and Sahu (2018b), Dangi and Kumar (2013), Ravikumar (2013), and, Sharma and Kukreja (2013) have used statistics of ATM penetration to study the extent of FI. This study uses the data of off-site ATMs for a better understanding of the ATM penetration, as they are stand alone ATMs through which people are able to avail banking services even if there are no branches of a bank. Since on-site ATMs are located in the branch premises and the bank-branch data is already considered as an input variable, the data of on-site ATMs is ignored here.

Total asset size. This directly represents the bank size. It is used as a substitute for capital input which facilitates production of outputs and helps in earning revenue (Maity, 2020). The bank branch's scale of operations also depends on asset size. In previously studies by, Kumar and Gulati (2008), Das et al. (2004), Maity (2020), Baidya (2012), Khatri (2004), Marjanović et al. (2018), and, Maity and Sahu (2018b), total asset size has been considered as an input variable.

Number of employees. This input variable indicates the provision of better customer reach through the service rendered by employees. An increase in numder of employees will definitely help in facilitating a a higher number of customers with improved service availability (Kumar & Gulati, 2008; Das et al., 2004; Baidya & Mitra, 2012; Baidya, 2012; Marjanović et al., 2018).

Output Variables
Number of no-frill accounts. Generally this includes the number. of accounts opened with a zero balance or a minimal balance, i.e., accounts that are opened under FI schemes. The data is inclusive of Pradhan Mantri Jan DhanYojna (PMJDY) accounts, Basic Savings Bank Deposit (BSBD) accounts and other FI accounts. It represents the number of vulnerable unbanked individuals being brought in to the formal financial setup which can be treated as an output. Bhattacharyya et al. (1997); Ketkar and Ketkar (2008); and, Maity and Sahu (2020) have used a similar variable, namely deposits, as an output in their studies.

Loans and advances under priority sector lending. This includes loans offered to MSMEs, affordable housing, education, social infrastructure, export credit and to weaker sections which are – the agriculture and animal husbandry sector, SHGs, craftsmen, weavers, artisans, small cottage industries, and micro-businesses. Studies by Debnath and Shankar (2008), Mazumdar (2019), Charnes et al. (1978), Bhatia and Mahendru (2015), Chatterjee and Sinha (2006) have also treated advances by commercial banks as outputs.

Number of people attending financial literacy camps (FLCs). In the semi-urban and rural regions banks are conducting literacy camps as an initiative under FI, where they provide basic financial literacy and debt counseling to the financially illiterate and unbanked masses. The data under FLCs considered for the study includes people who are provided with financial education in the literacy camps held by banks in different regions of India. FLCs help in increasing financial awareness of the unbanked masses which can directly help in increasing the extent of FI. Moreover, Singh (2014), Ghosh & Ghosh (2014), Gupta and Singh (2013), and, Kaur and Walia (2016) have incorporated financial literacy data as a variable.

Statistical and Econometric Tests Used

In this study, banks' technical efficiency towards achieving FI is measured based on their efficiency score. Then, a comparative evaluation of PSBs and PVBs is done to find out which group is better in their task of delivering FI. For studying the nature, range of dispersion and variation in the data set, descriptive statistics are used. They include of mean, standard deviation, minimum and maximum values. Further, correlation is computed to measure the degree of association among all the 7 selected variables to satisfy the isotonicity test (Golany & Roll, 1989).

Computation of the efficiency scores is done through the non-parametric statistical measure known as DEA, developed by Charnes et al. in 1978. It is generally preferred for productivity measurement of the Decision Making Units (DMUs) having multiple input-output structures. Under this technique, efficiency of the sample DMUs, i.e., banks, are measured under two models – BCC Model (Banker Charnes & Cooper) and CCR Model (Charnes, Cooper & Rhodes). The CCR model calculates the OTE (Overall Technical Efficiency) scores based on the assumptions of CRS (Constant Returns to Scale) and BCC Model calculates Pure Technical Efficiency (PTE) scores based on the assumptions of VRS (Variable Returns to Scale) and the Scale Efficiency (SE) is calculated by dividing OTE by PTE. Assuming that there are 'n' DMUs, each with 'm' inputs and 's' outputs, relative efficiency score of a test DMU_o ("o" denotes a focal DMU) is acquired by solving following model:

$$\max \frac{\sum_{r=1}^{s} v_r y_{ro}}{\sum_{i=1}^{m} u_i x_{io}} \qquad (1)$$

Subject to

$$\frac{\sum_{r=1}^{s} v_r y_{rj}}{\sum_{i=1}^{m} u_i x_{ij}} \leq 1; (j = 1, 2, \ldots, n); \ u_i, v_r \geq 0$$

where, $i = 1, 2, \ldots, m$; $r = 1, 2, \ldots, s$; y_{rj} = output r produced by DMU$_j$; x_{ij} = input i utilized by DMU$_j$; v_r = weight of output r; u_i = weight of input j. To evaluate each DMU's relative efficiency score, it is transformed into a linear programming problem.

$$\max \sum_{r=1}^{s} v_r y_{ro} \hspace{3cm} (2)$$

Subject to

$$\sum_{r=1}^{s} v_r y_{rj} - \sum_{i=1}^{m} u_i x_{ij} \leq 0; (j = 1, 2, \ldots, n); \ \sum_{i=1}^{m} u_i x_{ij} = 1; \ u_i, v_r \geq 0$$

The score value 1 indicates efficient DMUs and value less than 1 indicates inefficient DMUs (i.e. they have a scope of increasing their output level with the same quantity of input).

Analysis and Findings

In this section, a detailed data analysis is carried out for measuring the efficiency of the two bank groups in achieving the goal of FI. The section starts with descriptive statistics (see Table 1) to reflect on the nature of the data set. The high standard deviation in some of the variables indicates a high dispersion range in the data series, i.e., unstable data set, and the minimum and maximum values of some variables in the data series carry extreme values which indicate the different size and scale at which the banks are operating.

Table 1: Descriptive Statistics

Variables	Observations	Mean	SD	Minimum	Maximum
Employees	176	53,816	63,840	6,925	2,75,944
Branches	176	4,567	5,240	680	22,488
Asset Size	176	9,10,854	16,67,374	53,518	67,16,831
Off-Site ATMs	176	4,007	5,870	299	23,670
PSL	176	91,104	96,373	12,986	4,15,195
No-Frill A/Cs	176	157	185	4	717
FLCs Beneficiaries	176	9,40,547	12,49,904	12,892	43,38,778

Before performing the efficiency analysis under the DEA model, the researchers examined the isotonicity test (Golany & Roll, 1989) of input and output variables considered for the study. As per this assumption, an increase in any input should not result in a decrease in any of the output variables. According to Table 2, on the correlation matrix, the variables are positively correlated with no negative correlation, hence, satisfying the assumption of isotonicity.

Table 2: Correlation Matrix

Variables	Employees	Branches	Asset Size	Off-Site ATMs	PSL	No-Frill A/Cs	FLCs Beneficiaries
Employees	1						
Branches	0.9692	1					
Asset Size	0.3404	0.2749	1				
Off-Site ATMs	0.9489	0.8757	0.5579	1			
PSL	0.9901	0.9806	0.3296	0.9206	1		
No-Frill A/Cs	0.8416	0.8946	0.2054	0.7714	0.8673	1	
FLCs Beneficiaries	0.6593	0.5722	0.1693	0.6078	0.6718	0.5249	1

The inputs including number of employees, branches, ATMs and asset size have a positive impact on the outputs of No-frill A/Cs, people benefitted from FLCs and advances under PSL. Hence, we accept our alternative hypothesis (H_1) which states that the banks play a positive role in implementing the FI programme.

The average TE scores as shown in Table 3 calculated as per CCR and BCC model reveal that the selected sixteen banks are 93.5% and 97.44% efficient respectively. As per CCR model, PSBs and PVBs are at a 91.71% and 95.3% efficiency level respectively and as per BCC model, PSBs and PVBs are at a 96.84% and 98.05% efficiency level respectively. Under the CCR model, there are eight banks which are most efficient with an OTE score of 1, out of which, four are PSBs and four are PVBs. Whereas, under the BCC model 12 banks have topped the list with a PTE score of 1, out of which six banks are PSBs and six are PVBs.

Table 3: Technical Efficiency Scores under BCC and CCR Model

DMUs	OTE Score (CCR Model)	PTE Score (BCC Model)	SE Score	RTS
Bank of Baroda (BOB)	0.8928	1	0.8928	Decreasing
Bank of India (BOI)	0.7979	0.8032	0.9934	Increasing
Canara Bank (CNRB)	1	1	1	Constant
Central Bank of India (CBI)	1	1	1	Constant
Punjab National Bank (PNB)	0.8964	0.9439	0.9497	Decreasing
State Bank of India (SBI)	0.7496	1	0.7496	Decreasing
Syndicate Bank (SYB)	1	1	1	Constant
Union Bank of India (UBI)	1	1	1	Constant
Axis Bank (AXIS)	0.9364	0.9492	0.9865	Increasing
Federal Bank (FBL)	0.9269	1	0.9269	Increasing
HDFC Bank (HDFC)	1	1	1	Constant
ICICI Bank (ICICI)	0.8891	0.8948	0.9936	Decreasing
Jammu & Kashmir Bank Ltd (JKBL)	0.8716	1	0.8716	Increasing
Karnataka Bank Ltd (KBL)	1	1	1	Constant
Kotak Mahindra Bank (KMB)	1	1	1	Constant
South Indian Bank Ltd (SIBL)	1	1	1	Constant
Average of PSBs & PVBs	0.9350	0.9744	0.9603	
Average of PSBs	0.9171	0.9684	0.9482	
Average of PVBs	0.9530	0.9805	0.9723	

Note: OTE = Overall Technical Efficiency; PTE = Pure Technical Efficiency; SE = Scale Efficiency; RTS = Returns to scale

The banks that are efficient under both the models, CNRB, CBI, SYB, UBI, HDFC, KBL, KMB and SIBL having an OTE score of 1, form the efficient frontier and are termed benchmarks (Kumar & Gulati, 2008; Gulati, 2011).

The TE scores also suggest that if PSBs want to produce their outputs on an efficient frontier, then only 91.71% (as per CCR) and 96.84% (as per BCC) of the inputs (currently in use) will be required. If the PVBs produce their outputs on an efficient frontier then they require 95.30% (as per CCR) and 98.05% (as per BCC) of their current inputs. Alternatively, PSBs have the capacity of producing outputs 1.09 times (1/0.9171) and the PVBs have the capacity of producing outputs around 1.049 times (1/0.9530) by using the present level of inputs in use. Moreover, such

efficient utilization can be done through the adoption of advanced and improved technology and managerial skills (Maity, 2020). Hence, from the above calculations it can be said that the two models represent the ability of the PSBs and PVBs to transform their input resources into their outputs, i.e., financial services (Bhattacharyya et al., 1997). In other words, the PSBs can reduce their usage of inputs by 8.29% (as per CCR) and 3.16% (as per BCC) and the PVBs can reduce their inputs by 4.7% (as per CCR) and 1.95% (as per BCC) in order to attain 100% technical efficiency. The scores clearly indicate that the PVBs are more efficient than the PSBs under both the models and therefore, are efficient in their task of FI. Hence, we accept our alternative hypothesis (H_2) which states that there is a significant difference between the technical efficiency of the public and private sector banks in relation to the FI initiatives.

Further, the banks with OTE scores less than 1, are considered less efficient or inefficient. There are eight inefficient banks with OTE score less than 1 out of which four are PSBs and four are PVBs. Since these banks cannot be labeled as equally inefficient, they are further classified into three groups based on their quartile values to analyze their degree of inefficiency in detail. The classification is based on the OTE scores of all the inefficient banks derived from CCR model under CRS assumption.

Table 4: Classification of Banks Based on OTE Score

Category	Name of DMUs
Efficient	Canara Bank; Central Bank of India; Syndicate Bank; Union Bank of India; HDFC Bank; Karnataka Bank; Kotak Mahindra Bank; South Indian Bank
Below average	State Bank of India; Bank of India
Average	Bank of Baroda; Punjab National Bank; ICICI Bank; Jammu & Kashmir Bank
Marginally inefficient	Axis Bank; Federal Bank

As per Table 4, the banks are categorized into four groups . The banks with an OTE score of 1 are labeled as 'efficient' while the banks whose OTE score lies above 3rd quartile (0.9192) are termed as 'marginally inefficient' which requires a slight improvement in their allocative efficiency by minimizing the input wastage in order to achieve maximum efficiency. The banks with OTE scores between the 1st and 3rd quartile (i.e., between 0.8163 and 0.9192) are 'average' and require greater improvements in their resource wastage minimization, technological advancements

and employee productivity. In the category of 'below average' are the banks with OTE scores below the 1st quartile (0.8163) and they are the most inefficient banks that require significant improvements in its resource wastage minimization as they operate at an inefficient scale size.

In DEA, efficient DMUs forming the efficient frontier are used as the reference set for benchmarking of inefficient DMUs. In the benchmarking technique, efficient DMUs are placed as a benchmark for their inefficient counterparts. The DMUs with maximum occurrence as a benchmark for inefficient ones is considered to be the most robust, a global leader or an all-rounder (Kumar & Gulati, 2008; Baidya, 2012). Hence, efficient DMUs are discriminated based on their frequency of occurrence. The efficient bank with a maximum appearance in the reference set is an indication of its exemplary operating practices. The ones with a lower frequency of occurrence cannot be placed as an imitable model for the inefficient banks. Since they may have improper or odd input-output mix, even with a slight decrease in their outputs or a nominal increase in their inputs, they may fail to attain 100% efficiency (Kumar & Gulati, 2008). Moreover, the efficient DMUs with zero frequency of occurrence on the reference set are labeled as 'efficient by default' and are not worthy being followed by the inefficient banks. They lack the desired characteristics of efficient DMUs since they have more chances of dropping out of the efficient frontier if minute changes in the study period or in the input-output structure is made. Hence, they are considered 'efficient by chance or default' (Kumar & Gulati, 2008).

Table 5: Ranking of the Banks

Name of the Bank	OTE Score	Benchmark Times	Rank
Bank of Baroda	0.8928	-	XII
Bank of India	0.7979	-	XV
Canara Bank	1	6	I
Central Bank of India	1	1	VI
Punjab National Bank	0.8964	-	XI
State Bank of India	0.7946	-	XVI
Syndicate Bank	1	4	III
Union Bank of India	1	5	II
Axis Bank	0.9364	-	IX
Federal Bank	0.9269	-	X

Name of the Bank	OTE Score	Benchmark Times	Rank
HDFC Bank	1	2	V
ICICI Bank	0.8891	-	XIII
Jammu & Kashmir Bank Ltd	0.8716	-	XIV
Karnataka Bank Ltd	1	1	VI
Kotak Mahindra Bank	1	4	III
South Indian Bank Ltd	1	1	VI

Table 5 shows the ranking of the efficient banks based on the number of times they have appeared as a benchmark for the inefficient banks. On the basis of the frequency of occurrence in the reference set, Canara Bank has appeared the maximum number of times (six times) as a benchmark. In relation to FI, it is the most robust bank with Rank-I. Next is the Union Bank of India with Rank-II with a frequency of benchmark five. Kotak Mahindra Bank and Syndicate Bank with an equal number of appearance of four times share the Rank-III, followed by HDFC Bank (Rank -V). Central Bank of India, Karnataka Bank Ltd and South Indian Bank Ltd are at Rank-VI with one time appearance.

A discrimination of the inefficient banks is also presented in Table 5, where they are ranked based on their OTE scores. Here, Axis Bank with 93.64% efficiency and Federal Bank with 92.69% efficiency, being 'marginally inefficient' (as per Table 4), are ranked at Rank-IX and Rank-X respectively. They require slight improvements in their allocative efficiency to acquire 'efficient' position. The 'average banks' starting from Rank-XI to Rank-XIV include Punjab National Bank, Bank of Baroda, ICICI Bank and Jammu & Kashmir Bank Ltd. The position held by Bank of India and State Bank of India are at Rank-XV and Rank-XVI respectively, having below average efficiency and needing serious improvements in their operational practices, i.e., minimizing inputs wastage. In other words, they need to reduce their input-output slacks since they are scale inefficient.

Discussion

The prime focus of this study was to judge the technical efficiency of PSBs and PVBs in accomplishing their FI initiatives. For analyzing the efficiency level of the banks, the DEA model, which is generally used in multiple input-output scenarios, was used. Under this model, the TE scores of 16 banks were calculated in assessing their role in FI. Before beginning the analysis, the reliability of input and output factors selected for the study were verified through descriptive statistics to check

data spread and stability. Further, the correlation of input and output was considered to check whether they satisfy the assumption of isotonicity. The high positive correlation among all the selected variables provides authenticity to consider the DEA methodology.

Under the CCR model, there are eight banks which are the most efficient with the OTE score of 1, out of which four are PSBs and four are PVBs. Under BCC, 12 banks have topped the list with the PTE score of 1, out of which six banks are PSBs and six are PVBs. Therefore, in both models, there are an equal number of PSBs and PVBs that are technically efficient. According to the average OTE scores, the PVBs at 3.59% are more technically efficient than PSBs and the result is similar to Gulati (2011) where the PVBs are identified to be 4% more technically efficient than the PSBs in terms of efficient input utilization. The banks which are efficient under both the models are Canara Bank, Central Bank of India, HDFC Bank, Union Bank of India, South Indian Bank Ltd., Syndicate Bank, Kotak Mahindra Bank, and Karnataka Bank Ltd. having an OTE score of 1 forming the efficient frontier. Similarly, Debnath and Shankar (2008) find Canara Bank, Central Bank and Kotak Mahindra Bank as the most efficient ones in their study. In another study, Gulati (2011) has identified HDFC and Kotak in the efficient category. The average OTIE, pure technical inefficiency (PTIE) and scale inefficiency (SIE) for all 16 DMUs is around 6.5%, 2.56% and 3.97% respectively, clearly indicating that these banks are more scale inefficient than being managerially inefficient. Further, the OTIE, PTIE and SIE of PSBs are around 8.29%, 3.16% and 5.18% and for PVBs are 4.7%, 1.95% and 2.77% respectively. Therefore, PSBs have greater OTIE than the PVBs by 3.59%, and hence, they carry a greater amount of inefficiency than the PVBs. Both PSBs and PVBs are more scale inefficient than being managerially inefficient. Our result are similar to Gulati (2011) in terms of PVBs being more technically efficient than the PSBs. Debnath and Shankar (2008) also found Canara Bank, Central Bank of India, and Kotak Mahindra Bank as the most efficient ones in their study. Maity and Sahu (2018b) state that their sample banks were more scale inefficient than being managerially inefficient. However, some studies have opposite findings to ours where Kumar and Gulati (2008), Gulati (2011), Baidya (2012), and Maity (2020) found managerial inefficiency as the major reason for OTIE.

The remaining inefficient banks which are categorically distributed based on their quartile values in which State Bank of India and Bank of India, are placed under 'below average'. Bank of Baroda, Punjab National Bank, Jammu & Kashmir

Bank Ltd., and ICICI Bank are 'average' in efficiency and Axis Bank and Federal Bank are identified as 'marginally inefficient'. Result of the present study stand similar to Chatterjee (2006) where the State Bank of India was found to be a below average performer, and in contrast to findings by Majumdar (2019) where the State Bank of India and Punjab National Bank were identified to be in the marginally efficient category. Further, Debnath and Shankar (2008) identifies Punjab National Bank as the worst performer, and Baidy and Mitra (2012) find Bank of India as marginally efficient, and Syndicate Bank and Union Bank of India as least efficient. In contrast, our study finds the latter two as the most efficient and Bank of India as a below-average performer. Further, Maity and Sahu (2021b) find that PVBs and PSBs are operating at 90.20% and 86.04% efficiency levels respectively.

In benchmarking, Canara Bank has appeared the maximum number of times (i.e., 6 times) as a benchmark, being the most robust bank and securing the position of most efficient. Karnataka Bank Ltd., South Indian Bank Ltd. and Central Bank of India have the lowest frequency count of one and are termed as the least or marginally robust. In a previous study, Kumar and Gulati (2008) find State Bank of Bikaner and Jaipur as highly robust with maximum number of frequency counts as a benchmark for other banks and Punjab and Sind bank as the least robust with the lowest frequency of one.

Conclusion

The idea of FI is to provide affordable banking services to people who remain excluded from the formal financial circle. Banks assist the government in fulfilling its target of FI. The banks, on behalf of the government, spread awareness about FI schemes, provides basic financial literacy and, even acts as a delivery channel in schemes such as direct benefit transfer and affordable loan products to ensure that the benefits reach the targeted excluded groups (Chakrabarty, 2011). The world economies are aware of the paramount role of the formal banking system when it comes to FI, like, the introduction of Grameen Banks in Bangladesh in 1983 to provide small and micro-loans to financially vulnerable classes to assist in their financial stability and growth (Sahu et al., 2021), and the initiative of rural branch penetration by Nigeria in 1977 to ensure a speedy inclusion process in its rural backward areas (Kama & Adigun, 2013). Zimbabwe's focus on improving its banking penetration in order to enhance its FI strategy and compelling its MSMEs to open formal bank accounts (Sakarombe, 2018) is another example. The idea of an agent banking system in Malawi (like business correspondents) for spreading financial awareness on various banking products acts as a step towards inclusive

economy and provides an outlook on the strategic importance of banking structure for FI (Ferguson, 2011). Further, it has been found that in the Middle East and in North African countries, lack of basic banking infrastructure was the underlying factor behind the poor status of FI (Kama & Adigun, 2013). All these initiatives and findings provide a clear perspective on the importance of a formal banking structure for developing a vibrant and financially inclusive economy.

In examining the banks' efficiency, the researchers used DEA to calculate technical efficiency scores and carried out a detailed analysis on the findings. Based on the results of the 16 banks selected to study, there are 8 banks having full efficiency out of which 4 are PVBs and 4 are PSBs. These eight banks are technically more efficient in implementing FI initiatives that helped in improving the status of FI in India. Further, though the PSBs have impactful scores, still the PVBs have proved to be more technically efficient than the PSBs with better efficiency scores. Under both the DEA models, PVBs have outnumbered the PSBs in terms of efficiency score and hence PSBs carry a greater amount of inefficiencies compared to PVBs. The inefficiency in PSBs and PVBs is due to scale inefficiency rather than managerial inefficiency. Mostly, the PSBs fail in the efficient utilization of input resources, since they are not operating at an optimum scale. In order to improve scale inefficiency, they need to reduce the input-output slacks which can be done through adoption of advanced technology (Maity & Sahu, 2019b). Further, both groups of banks should also focus on employee productivity, technological improvements, etc. to improve managerial efficiency; in short, both groups require enhancement in managerial skills.

The key knowledge contribution of this study was in addressing some of the drawbacks in previous research in the measurement of FI related variables, such as excluding credit facilities that do not contribute to FI, and focusing special attention on off-site ATMs to better reflect the customer reach of FI. Most importantly, the study included financial literacy improvement initiatives, such as awareness camps, in measuring the FI outcomes. The findings of this research have implications for different stakeholders. The banks can know about their extent of efficiency compared to its peers in order to attain technical expertise in the field of FI. It encourages policymakers to promote digital banking and plan various other cost effective measures which can reduce the input slack of the banks and help in efficient utilization of resources. To customers, the efficient banks can provide better services at reduced cost. The significance of 'awareness camps' or 'literacy camps' in promoting FI, which is highlighted in this study, can provide a fresh view to researchers, who can structure their study in this area.

Policy and Managerial Implications

The study opines that PSBs being less technically efficient than the PVBs can adopt technological enhancement in order to improve their efficiency i.e., adopting tech-based innovative techniques to fuel the FI drive. Adoption of cost-effective measures like kiosk banking in regions where opening a physical branch for a bank is either not possible or not profitable, promoting internet or digital banking among its customers by providing them financial incentives such as refunds, cash backs, discounts, etc., may promote digital payments and reduce their dependence on the branch. Recently, Peru launched Modelo Peru, an e-payment gateway to promote digital payments. Brazil and Indonesia launched satellite linked riverboat floating banks to provide basic banking facilities to the excluded groups thriving on the remote riverside regions. Kenya's banks launched wifi-connected trucks to serve customers dwelling in remote regions and a digital MFI named Musoni which provides small and micro loans within 72 hours. Similarly, Philippines has focused on improving the condition of financial literacy in its financially excluded areas by setting up advocacy units for running literacy programmes (Ernst & Young, 2017). India can adopt similar initiatives to increase the efficiency of FI.

With a large number of branches, ATMs and employees, some of the PSBs have a better geographical outreach and massive manpower which can be a great tool for an impactful promotion of FI; yet they lag behind in efficient ulitisation of these resources. On the other hand, PVBs are more efficient and hence, they should jointly promote the culture of FI. This collaboration can help the PVBs to have a better outreach and PSBs to improve their efficiency since it will help in reducing the cost involved in promoting FI programmes. Non-banking corporates can take up the challenge of FI as their corporate social responsibility (Michael & Sharon, 2014), where, they can partner with banks by providing funds for costs involved in setting up financial literacy centers, running the literacy programmes, sponsoring the business correspondents, etc.

Limitations of the Study

This entire study was based on secondary data collected from information published by the banks on their websites, their annual reports etc. and the current scenario of FI could have been more clearly presented if the study was conducted with primary data. The type of variables taken for the technical analysis may have their own shortcomings in presenting the accurate scenario of FI. Further, in this study, the analysis was conducted on only 16 banks from 2 groups due to

unavailability of the required data. Hence, these limitations paves way for future studies with different financial institutions like co-operative banks, micro-finance institutions, payment banks, RRBs etc. with different variables along with other statistical tests which can generate new or different findings on the status of FI.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

References

Agarwala, V., Maity, S., & Sahu, T. N. (2022). Female entrepreneurship, employability and empowerment: impact of the Mudra loan scheme. *Journal of Developmental Entrepreneurship*, *27*(1). https://doi.org/10.1142/S1084946722500054

Al-Chahadah, A. R., Refae, G. A. E., & Qasim, A. (2020). The impact of financial inclusion on bank performance: The case of Jordan. *International Journal of Economics and Business Research*, *20*(4), 483–496. https://www.inderscience.com/info/inarticle.php?artid=111096

Amatus, H., & Alireza, N. (2015). Financial inclusion and financial stability in Sub-Saharan Africa (SSA). *International Journal of Social Sciences*, *36*(1), 2305–4557.

Ananth, S., & Öncü, T. S. (2013, February 16). Challenges to financial inclusion in India: The case of Andhra Pradesh. *Economic and Political Weekly*, *48*(7), 77–83. https://www.jstor.org/stable/23391312

Archana, H. N. (2013). Financial inclusion–Role of institutions. *Innovative Journal of Business and Management*, *2*(4), 44–48. https://www.innovativejournal.in/index.php/ijbm/article/view/419

Bagli, S., & Dutta, P. (2012). A study of financial inclusion in India. *Radix International Journal of Economics & Business Management*, *1*(8), 1–18.

Baidya, M. K., (2012). Multiple aspects of Indian banking efficiency through DEA approach. *Research Bulletin, Institute of Cost Accountants of India*, *36*.

Baidya, M. K., & Mitra, D. (2012). An analysis of the technical efficiency of Indian public sector banks through DEA approach. *International Journal of Business Performance Management*, *13*(3-4), 341–365. https://www.inderscienceonline.com/doi/abs/10.1504/IJBPM.2012.047300

Bhatia, A., & Mahendru, M. (2015). Assessment of technical efficiency of public sector banks in India using data envelopment analysis. *Eurasian Journal of*

Business and Economics, *8*(15), 115–140.
https://www.ejbe.org/index.php/EJBE/article/view/145

Bhattacharyya, A., Lovell, C. K., & Sahay, P. (1997). The impact of liberalization on the productive efficiency of Indian commercial banks. *European Journal of Operational Research*, *98*(2), 332–345. https://doi.org/10.1016/S0377-2217(96)00351-7

Chakrabarty, K. C. (2011, November). Financial inclusion and banks: Issues and perspectives. *RBI Bulletin*.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*(6), 429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Chatterjee, B., & Sinha, R. P. (2006). Cost efficiency and commercial bank lending: some empirical results. *The Indian Economic Journal*, *54*(1), 145–163. https://doi.org/10.1177/0019466220060109

Chatterjee, G. (2006). Is inefficiency of banks in India a cause for concern? Evidence from the post-reforms era. *Journal of Emerging Market Finance*, *5*(2), 151–182. https://doi.org/10.1177/097265270600500203

Chauvet, L., & Jacolin, L. (2017). Financial inclusion, bank concentration, and firm performance. *World Development*, *97*, 1–13. https://doi.org/10.1016/j.worlddev.2017.03.018

Cull, R., Demirgüç-Kunt, A., & Lyman, T. (2012). *Financial inclusion and stability: What does research show?* World Bank. https://openknowledge.worldbank.org/handle/10986/9443

Dangi, N., & Kumar, P. (2013). Current situation of financial inclusion in India and its future visions. *International Journal of Management and Social Sciences Research*, *2*(8), 155–166.

Das, A., Nag, A. & Ray, S. (2004). *Liberalization, ownership, and efficiency in Indian banking: A nonparametric approach* (Working Paper 2004-29).University of Connecticut.

Dash, M., & Charles, C. (2009). A study of technical efficiency of banks in India. http://dx.doi.org/10.2139/ssrn.1417376.

Davidovic, M., Uzelac, O., & Zelenovic, V. (2019). Efficiency dynamics of the Croatian banking industry: DEA investigation. *Economic Research-Ekonomska istraživanja*, *32*(1), 33–49. https://doi.org/10.1080/1331677X.2018.1545596

Debnath, R. M., & Shankar, R. (2008). Measuring performance of Indian banks: An application data envelopment analysis. *International Journal of Business Performance Management*, *10*(1), 57–85.

Dhar, S. (2012). Banking reforms for financial inclusion: Performance of selected Indian banks. *Amity Management Review*, *2*(2), 34–39. https://www.amity.edu/jaipur/amr/jun-dec-2012.html

Dhar, S. (2015). *Role of electronic banking in financial inclusion.* https://ssrn.com/abstract=2574608

Ditta, A. S. A., & Saputra, A. (2020). Financial inclusion and banking performance in Indonesia. *Journal of Accounting, Finance and Auditing Studies*, *6*(2), 50–69. https://www.um.edu.mt/library/oar/handle/123456789/54041

Ernst & Young (2017). *Innovation in financial inclusion: Revenue growth through innovative inclusion.* https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/trust/EY-innovation-in-financial-inclusion.pdf?download

Ferguson, M. (2011). *Branchless banking and rural outreach in Malawi: Opportunity International Bank of Malawi's impact on the market.* Microfinance Opportunities. http://www.fsassessment.umd.edu/publications/pdfs/Malawi-Financial-Landscape-Endline.pdf

Ghosh, M. M., & Ghosh, A. (2014). Financial inclusion strategies of banks: Study of Indian states. *International Journal of Applied Financial Management Perspectives*, *3*(2), 990–996.

Golany, B., & Roll, Y. (1989). An application procedure for DEA. *Omega*, *17*(3), 237–250. https://doi.org/10.1016/0305-0483(89)90029-7

Gulati, R. (2011). Evaluation of technical, pure technical and scale efficiencies of Indian banks: An analysis from cross-sectional perspective. *ProceediInngs of the 13th Annual Conference on Money and Finance in the Indian economy* (pp. 1–28).

Gupta, P., & Singh, B. (2013). Role of literacy level in financial inclusion in India: Empirical evidence. *Journal of Economics, Business and Management*, *1*(3), 272–276. http://www.joebm.com/index.php?m=content&c=index&a=show&catid=31&id=325

Issaka Jajah, Y., Anarfo, E. B., & Aveh, F. K. (2020). Financial inclusion and bank profitability in Sub-Saharan Africa. *International Journal of Finance & Economics*. https://doi.org/10.1002/ijfe.2135

Iqbal, B. A., & Sami, S. (2017). Role of banks in financial inclusion in India. *Contaduría y Administración*, *62*(2), 644–656. https://doi.org/10.1016/j.cya.2017.01.007

Jisha Joseph, M., & Varghese, D. T. (2014). Role of financial inclusion in the development of Indian Economy. *Journal of Economics and Sustainable*

Development, *5*(11), 6–11.
https://www.iiste.org/Journals/index.php/JEDS/article/view/13832

Kama, U., & Adigun, M. (2013). *Financial inclusion in Nigeria: Issues and challenges* (CBN Occasional Paper, 45).

Kaur, J., & Walia, D. N. (2016). A review study on Pradhan Mantri Jan DhanYojana–A new scheme towards financial inclusion. *International Journal of Business Management and Scientific Research*, *18*, 20–32.

Ketkar, K. W., & Ketkar, S. L. (2008). Performance and profitability of Indian banks in the post-liberalization period. *Proceedings of the World Congress on National Accounts and Economic Performance Measures for Nations,* 13–17.

Khatri, D. (2004). *Performance of Indian banks - Stochastic frontier approach*. https://ssrn.com/abstract=639801

Kumar, C., & Mishra, S. (2011). Banking outreach and household level access: Analyzing financial inclusion in India. *Proceedings of the 13th Annual Conference on Money and Finance in the Indian Economy* (pp. 25–26).

Kumar, S., & Gulati, R. (2008). An examination of technical, pure technical, and scale efficiencies in Indian public sector banks using data envelopment analysis. *Eurasian Journal of Business and Economics*, *1*(2), 33–69. https://www.ejbe.org/index.php/EJBE/article/view/1

Kumar, M., Charles, V., & Mishra, C. S. (2016). Evaluating the performance of Indian banking sector using DEA during post-reform and global financial crisis. *Journal of Business Economics and Management*, *17*(1), 156–172. https://doi.org/10.3846/16111699.2013.809785

Kumar, V., Thrikawala, S., & Acharya, S. (2021). Financial inclusion and bank profitability: Evidence from a developed market. *Global Finance Journal*. Advance online publication https://doi.org/10.1016/j.gfj.2021.100609

Lakshmi, P., & Visalakshmi, S. (2013). Impact of cooperatives in financial inclusion & comprehensive development. *Journal of Finance and Economics*, *1*(3), 49–53. http://pubs.sciepub.com/jfe/1/3/4/

Le, T.-H., Chuc, A. T., & Taghizadeh-Hesary, F. (2019). Financial inclusion and its impact on financial efficiency and sustainability: Empirical evidence from Asia. *Borsa Istanbul Review*, *19*(4), 310–322. https://doi.org/10.1016/j.bir.2019.07.002

Maity, S. (2019). Financial inclusion status in North Eastern region: An evidence of commercial banks. *International Journal of Research in Applied Management, Science and Technology*, *4*(3), 1–11.

Maity, S. (2020, April 15). Are private sector banks really more efficient than public sector banks?–A comparative analysis using DEA. *NMIMS Management*

Review, *38*(2), 82–92. https://management-review.nmims.edu/2020/04/are-private-sector-banks-really-more-efficient-than-public-sector-banks-a-comparative-analysis-using-dea/

Maity, S., & Sahu, T. N. (2017). Pre-merger performance measures of State Bank of India and its associate banks using Data Envelopment Analysis. *Business Spectrum*, *7*(2), 16–26. https://iaasouthbengalbranch.org/journal.php

Maity, S., & Sahu, T. N. (2018a). Bank branch expansion and financial inclusion: Evidence from selected commercial banks in India. *Al-Barkaat Journal of Finance & Management*, *10*(1), 48–65. https://indianjournals.com/ijor.aspx?target=ijor:abjfm&volume=10&issue=1&article=005

Maity, S., & Sahu, T. N. (2018b). Financial inclusion in India: Role of public and private sector banks. *SCMS Journal of Indian Management*, *15*(4), 62–73. https://www.scms.edu.in/past_issues/article?journal_id=67

Maity, S., & Sahu, T. N. (2019a). A study on regional disparity of bank performance towards financial inclusion. *Management Today*, *9*(1), 24–31. http://www.mgmt2day.griet.ac.in/Jan%20-%20Mar%20%202019%20Vol%209%20-%20No%201.html

Maity, S., & Sahu, T. N. (2019b). Is the efficiency of banks degenerating due to the mounting of non-performing assets? An empirical investigation using DEA. *Malaysian Management Journal, 23*, 65–86. https://doi.org/10.32890/mmj.23.2019.9685

Maity, S., & Sahu, T. N. (2020). Role of public sector banks towards financial inclusion during pre and post introduction of PMJDY: A study on efficiency review, *Rajagiri Management Journal*, *14*(2), 95–105. https://doi.org/10.1108/RAMJ-03-2020-0009

Maity, S., Sahu, T. N. & Biswas, D. (2020). Assessing efficiency of private sector banks in India- An empirical investigation using DEA. *International Journal of Financial Services Management*, *10*(2), 138–155. https://www.inderscienceonline.com/doi/abs/10.1504/IJFSM.2020.110223

Maity, S., & Sahu, T. N. (2021a). Financial inclusion in north-eastern region: An investigation in the state of Assam. *Vilakshan - XIMB Journal of Management*, Advance online publication. https://doi.org/10.1108/XJM-09-2020-0118

Maity, S., & Sahu, T. N. (2021b). How far the Indian banking sectors are efficient? : An empirical investigation, *Asian Journal of Economics and Banking*. Advance online publication. https://doi.org/10.1108/AJEB-02-2021-0016

Marcelin, I., Egbendewe, A. Y., Oloufade, D. K., & Sun, W. (2021). Financial inclusion, bank ownership, and economy performance: Evidence from developing countries. *Finance Research Letters*, *46*. https://doi.org/10.1016/j.frl.2021.102322.

Marjanović, I., Stanković, J. J., & Popović, Ž. (2018). Efficiency estimation of commercial banks based on financial performance: Input oriented DEA CRS/VRS Models. *Economic Themes*, *56*(2), 239–252. http://www.economic-themes.com/56/number/2/article/6

Mazumdar, M. D. (2019). An empirical study on measurement of efficiency of selected banks in India. *Indian Journal of Economics and Development*, *7*(3), 1–5. https://ijed.in/articles/an-empirical-study-on-measurement-of-efficiency-of-selected-banks-in-india

Michael, O. B., & Sharon, O. O. (2014). Financial system, financial inclusion and economic development in Nigeria. *International Journal of Management Sciences*, *2*(3), 139–148.

Mohan, T. T., & Ray, S. C. (2004*). Productivity growth and efficiency in Indian banking: A comparison of public, private, and foreign banks* (Department of Economics Working Paper No. 2004-27). University of Connecticut

Mukherjee, A., & Chakraborty, S. (2012). Financial inclusion of the poor and marginalised in Jharkhand: Analysis of the existing model. *International Journal on Research and Development-A Management Review*, *1*(1). 1–8. http://www.irdindia.in/journal_ijrdmr/volume_1_issue_1.html

Nthambi, E. K. (2015). *Financial inclusion, bank stability, bank ownership and financial performance of commercial banks in Kenya* (Unpublished doctoral dissertation). University of Nairobi.

Pant, B. (2016). Financial inclusion in Nepal: Policy review and prescriptions. *Economic Review*, *28*(2), 1–18. https://www.nrb.org.np/economic-review/30918/

Paramasivan, C., & Kamaraj, R. (2015). Commercial bank's performance on Pradhan Mantri Jan Dhan Yojana. *International Journal of Scientific Research and Education*, *3*, 3595–3603.

Porkodi, S., & Aravazhi, D. (2013). Role of microfinance and self-help groups in financial inclusion. *International Journal of Marketing, Financial Services & Management Research*, *2*(3), 137–149.

Raman, A. (2012). Financial inclusion and growth of Indian banking system. *IOSR Journal of Business and Management*, *1*(3), 25–29. https://www.iosrjournals.org/iosr-jbm/pages/v1i3.html

Rao, C. S. D. N. (2013). Financial inclusion and Indian banking system–the way ahead. *International Journal of Innovative Research and Practices*, *1*(7), 19–28.

Rao, K. S., & Baza, A. U. (2017). Barriers to access to and usage of financial services in Ethiopia. *Business and Economic Research*, *7*(1), 139–149. https://doi.org/10.5296/ber.v7i1.11034

Ravikumar, T. (2013). *Assessing role of banking sector in financial inclusion process in India*. Christ University.

Saha, A. & Ravisankar, T. S. (2000). Rating of Indian commercial banks: A DEA approach. *European Journal of Operational Research*, *124*(1), 187–203. https://doi.org/10.1016/S0377-2217(99)00167-8

Sahu, T. N., Agarwala, V., & Maity, S. (2021). Effectiveness of microcredit in employment generation and livelihood transformation of tribal women entrepreneurs: Evidence from PMMY. *Journal of Small Business & Entrepreneurship*. Advance online publication. https://doi.org/10.1080/08276331.2021.1928847

Sakarombe, U. (2018). Financial inclusion and bank stability in Zimbabwe. *Journal of Academic Research in Economics and Management Sciences*, *7*(4), 121–138. http://dx.doi.org/10.6007/IJAREMS/v7-i4/5193

Sharma, A., & Kukreja, S. (2013). An analytical study: Relevance of financial inclusion for developing nations. *International Journal of Engineering and Science*, *2*(6), 15–20.

Shihadeh, F., & Liu, B. (2019). Does financial inclusion influence the Banks risk and performance? Evidence from global prospects. *Academy of Accounting and Financial Studies Journal*, *23*(3), 1–12. https://www.abacademies.org/articles/does-financial-inclusion-influence-the-banks-risk-and-performance-evidence-from-global-prospects-8284.html

Shihadeh, F. H., Hannon, A.(.T.)., Guan, J., Haq, I.u. and Wang, X. (2018). Does financial inclusion improve the banks' erformance? Evidence from Jordan. In J. W. Kensinger, .(Ed.), *Global tensions in financial markets* (*Research in finance* Vol. 34, pp. 117–138). Emerald Publishing

Singh, P. K. (2014). A study on financial inclusion-Role of Indian banks in implementing a scalable and sustainable financial inclusion strategy. *International Journal of Management (IJM)*, *5*(11), 103–110.

Sinha, D. R. P. (2009). Commercial bank performance in financial inclusion: A bilateral comparison model. https://www.researchgate.net/profile/Ram-Sinha/publication/228200250

Subrahmanyam, G. (1993). Productivity growth in India's public sector banks: 1979–89. *Journal of Quantitative Economics*, *9*(3), 209–223.

Tamatam, R., Dutta, P., Dutta, G. & Lessmann, S. (2019). Efficiency analysis of Indian banking industry over the period 2008–2017 using data envelopment analysis. *Benchmarking: An International Journal*, *26*(8), 2417–2442. https://doi.org/10.1108/BIJ-12-2018-0422

Tyagarajan, M. (1975, November 22). Expansion of commercial banking. An assessment. *Economic and Political Weekly*, *10*, 1819–1824. https://www.jstor.org/stable/40738371

Vo, D. H., & Nguyen, N. T. (2021). Does financial inclusion improve bank performance in the Asian region? Asian-Pacific Economic Literature. 35(2), 123–135. https://doi.org/10.1111/apel.12330

Zhao, T., Casu, B., & Ferrari, A. (2008). Deregulation and productivity growth: a study of the Indian commercial banking industry. *International Journal of Business Performance Management*, *10*(4), 318–343. https://www.inderscience.com/info/inarticle.php?artid=19990