Examining the off Balance Sheet Exposure and Efficiency of Indian Commercial Banks – A DEA Approach

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Abstract

The study examined the exposure and efficiency of select public and private sector banks towards off balance sheet items by applying Data Envelopment Analysis (DEA) on the key financial performance ratios of banks. The study covered a period of 5 years ranging from 2013 to 2017 and conducted a year wise analysis. The study selected 20 different type of variables (financial variables) for building Input –Output Model to test DEA for examining efficiency. These variables are acting as proxy variables for indicating the effect of Off balance sheet exposures on the financial health of the business. These variables are extracted from the financial statements of respective banks on a year on year basis and required adjustments are done. The study investigated the Off balance sheet exposures in the areas of Foreign Exchange Transactions, Guarantees, Acceptance and Endorsements etc., The proxy variables, so identified for the study are employed for understanding various efficiencies of banks like scale efficiencies involve Constant Returns to Scale (CRS), Variable Returns to Scale (VRS) and average efficiencies like Technical Efficiency (TE), Cost Efficiency (CE), Allocative Efficiency (AE). The study find out that throughout the study period, the select banks exhibited constant returns to scale, except CUB and AXIS Bank in the first year of study (2013) displayed increasing returns to scale due to heavy exposures. In the category of efficiency parameters, AXIS Bank and CUB are displaying lower efficiencies in the segment of private sector banks and Andhra Bank and OBC exhibiting lower efficiencies in the segment of public sector banks. Here lower efficiencies with references to cost savings aspects and output generation, this may be due to their scale of operations in the industry. The study concluded that large banks are exhibiting highest efficiencies than compared to small banks operating in the industry. This is definitely an area for further research to the industry and researchers to examine the direct effect of Off balance sheet transactions (IFRS amendments in this direction only), so that credit risk can be reduced considerably in the business. So that business houses can take up calculated risk in the international markets.

Keywords : Off Balance Sheet Exposures, Constant Returns to Scale, Variable Returns to Scale, Technical Efficiency, Cost Efficiency, Input-Output Orientation.

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Introduction

Off balance sheet items plays a promoinent role in the financial statements of banking companies and avaiation companies as a result they need to disclose in an appropritae manner like providing complete information regarding the Special Purpose Vehicles (SPVs) created for this purpose, Collateralized Debt Obligations (CDOs) etc., as suggested by the Companies Act, 1956 and IFRS.

Off balance sheet items are the highly volatile in nature and they are often referred as unbundling of intermediation (Boyd &Gertler, 1994). These items carries advantages like less funding requirements and cost savings, so that these

benefits can carried to customers. Earlier for these items and transactions, banks are not required to maintain any capital base, but as per current regulations banks need to maintain proper capital base (CAR), before entering into these transactions (accepting any contingent positions), as these transactions involves high amount of reputation risk and credit risk. Asset Liability Management (ALM) is a common practice in majority of the banks, due to mismatch of maturities between assets and liabilities products in the financial statements of banks. Due to these multiple reasons, banks need to rely on accepting positions in the form of Off balance sheet items and trading with varieties of risk.

Off balance sheet items are contingent items, embodied in the financial statements as a footnote and these items will provide information relating to future liabilities/assets rather than current scenario of business. Off balance sheet items in banks includes fee and commission based incomes (Auxiliary nature –Non interest income) with little investment. These are existing in the form of Foreign Exchange Transactions, Financial Derivative (includes Forwards, Futures, Options and Swaps) contracts engaged by banks for hedging and trading purposes, Guarantees (Letters of Credit), Endorsements, Loans etc., Nachane and Ghosh (2002) described them as contingent commitments or contracts, generate income to banks through non-traditional lines of business and are not captured as assets or liabilities under conventional accounting procedures. In the recent IFRS amendments in the area of fair value accounting, these type of items need to be disclosed and adjusted in the financial statements.

Literature Review

Literature Review coverage in this study mainly focused on two key areas, one is research relating to Data Envelopment Analysis (DEA), which is extensively covered in various sections of this research work viz., methodology section as well as in results section. Second part of literature review refers to application of DEA inBanking Sector among public and private enterprises.

Venkatesh. B (2009), examined technical efficiency measurement in transportation industry by applying DEA. The study disclosed that only 8 DMUs have scale efficiency and DMUs operating in the form of companies have reported higher technical efficiencies than compared to normal DMUs. A study on agricultural crop production by Umanath & Rajasekhar (2013) examined technical and scale efficiencies in select farms in Taminadu. The study applied random sampling technique for collection of data from respondents and concluded that majority of the farmers (47%) are not operating with optimal scale efficiencies. Extensive research is carried out by various researchers on off balance sheet exposures of banks, cautioning their risks in financing. In an another research study Kathivaran & Rajasekhar, et.al., (2018) applied DEA on irrigated and dry farms in Salem to estimate scale and technical efficiency and concluded that technical efficiency was less in irrigated farms than in dry farms, whereas scale efficiency was in reverse. There are numerous studies on agricultural economics and research viz., Deshpande (2003), Sreenivasa (2009) & Nasurudeen (2009), Orhan and Vedat (2011) studies investigated both technical and scale efficiencies in Agricultural economics on various crops viz., Rice, Dry Apricot farms, Tomato Production etc.,

Exponential growth witnessed in the research and publications on the applications of DEA approach and one such seminal work was conducted Emrouznejad and Yang (2017), conducted an extensive review of literature on numerous DEA works published in various journals and magazines during 1978-2016 in a period of 40 years across

various sectors both in public and private on efficiency related studies.

Recent studies on application of DEA in the area of banking conducted by Shaw and Guha, et.al. (2019) to examine the multiple aspects of technical efficiency of Indian Public Sector banks using DEA and for financial soundness indicators like CAMEL and Du-Pont Analysis employed in the study. The study selected twenty public sector banks for a period of 5 years and examined the financial soundness by ranking the banks using CAMEL and Du-Pont methodology and non-parametric tests also. The study fixed CAMEL Ratios as Input variables and Average Stock Return as Output Variable for running Input oriented VRS model and Super Efficiency Input Oriented VRS model for examination of technical efficiency of banks and ranked various DMUs (banks) as per their efficiency. DEA approach was adopted by many researchers viz., Houssine Tig and Hamed et.al (2017), Feng et.al, (2017) etc., and Grmanova et.al., (2018) for examining the various efficiencies of Tunisian Banks and Slovakia banks and concluded that large banks (size of operations) have more technical and super efficiency than compared with small and mid-sized banks, due to availability of funds in the market. Another consequential study by Yadav&Preethi, et.al (2019) on "evaluation of performance of public and private sector banks in India using DEA", investigated various efficiency of banks in terms of their cost and revenue parameters as input and output variables and concluded that few public and private sector banks have efficiency score less than 1 and it is clearly an area of improvement in the areas of revenue (interest income) and reducing the cost (NPA management).

Barrell& Davis, et.al., (2009) study on "Evaluating Off-Balance Sheet Exposures in Banking Crisis Determination Models" at NISER, is a pioneering work and is carried out to understand the probability of banking crisis in OECD economies (Belgium to USA, UK etc., 14 countries) between 1980 to 2007and its contribution to systematic risk of banks by developing the ratio of off to on balance sheet activities in an econometric model. The study found that this ratio has a positive and significant effect on probability of banking crisis. Further the study examined by changing various proxy variables viz., non-interest income, have a significant impact on variables like capital adequacy, liquidity etc., in logit regression model. Studies like Veronika (2012) examined off balance sheet activities in Czech Republic banks in order to examine the impact of credit risk and estimated expected loss arising out of off balance sheet items. In this study expected loss is assessed as a product of probability of default, loss given default and exposure at default and the study used Build-Up Method for business valuation. The study concluded that the select bank has operating with flexible structure with a proper diversification into multiple economic sectors. As a result risk spreading is happening on an appropriate basis.

Off balance sheet exposures of public sector banks in India studied (Swain and Panda (2017) in divergent dimensions to examine the credit risk, effect on various banking indicators like Net Interest Margin (NIM), Return on Assets (ROA), and Liquidity to Total Assets (LTA). Applied various linear regression models, keeping off balance sheet items as dependent variable concluded that NIM effecting negatively and whereas rest of the variables have positive effect on OBS. Similar studies conducted by various researchers viz., Sinha & Sinha (2005), Pratap (2005), Ghosh (2007) on off balance sheet exposures of Indian Banks.

Research Gap

Application of data envelopment analysis for examining efficiency related issues in

manufacturing firms is a regular practice. In case of service sector studies in this area are more delineated towards either technical or average efficiency related parameters and skewed towards either public sector banks exposure or private sector banks, but very few studies examined the off balance sheet exposures of both public and private sector banks in terms of efficiency related parameters. This research gap stimulated the interest of the researcher to further study the off balance sheet exposures of both public and private sector banks individually and year wise with a focus of Technical Efficiency and Average Efficiency parameters.

Objective of the Study

The primary objective of this study is to examine the off-balance sheet exposure and efficiency of Indian Commercial Banks (select public and private banks) by applying DEA frontier.

Methodology of the Study

The research is basically exploratory in nature and rests on ten commercial banks from both the segments of public and private sector. The banks selected for the study have sufficient exposure to off balance sheets items during the study period, which represents the diversity in their operations and exposures to different segments of business. The data for this study are collected from 10 banks (5- private sector & 5- public sector) annual financial statements and other necessary financial information, through the annual reports of 5 years (2013-2017). All the annual reports are obtained from respective bank's websites, which are publicly available. The choice of sample period is quite purposive and had a significance with reference to slew of reforms in the banking sector, motivated the researcher to conduct an in-depth research into this area. This study mainly emphasis on 20 variables, those are: total liabilities, unallocated liabilities, interest received, other incomes, advances, other assets, investments, fixed assets, cash balance and provisions to employees, unallocated assets, interest expenses (Kazan & Baydar, Sigh &Kaur), other expenses, deposits, other liabilities, borrowings, capital expenses, depreciation, reserves and surplus. For the purpose of efficiency analysis total liabilities, unallocated liabilities, interest received, other incomes, advances, other assets, investments, fixed assets, cash balance and provisions to employees are considered as output variable that is to be maximized and the other 10 variables are considered as input variables. As direct identification of Off balance sheet items is difficult process, few proxy variables are considered for examining their effect on financial statements of banks.

Data envelopment analysis (DEA)

Technique of efficiency measurement by applying DEA, introduced by Charnes, Cooper and Rhodes (1978) and after that modified version of DEA suggested by Banker, Charnes and Cooper (1984). DEA follows a relative approach in evaluation, as new entities are adding in the sample, efficiencies of existing entities will change with reference to new ones. So it stress on continuous improvement in the organizations, whether, they are banks, hospital industry, transportation, farming etc., In the process of evaluation it always suggest a room for improvement to DMUs. But there is always a debate in understanding the efficiencies either from output to input or Input to Output. As a result DEA has a flexibility in understanding both the models. There are various types of efficiency need to be examined viz., technical efficiency (TE), scale efficiency (SE), cost efficiency (CE)and allocative efficiency (AE) (Sherman & Zhu, 2006). Technical efficiency of the DMUs are measured by using the standard methodology M x N model i.e. multiple inputs and multiple out puts model by using open solver for Constant Returns to Scale

and by modifying this linear programming problem with the addition of a convexity constraint the study estimated Variable Returns to Scale. This procedure provides TE (technical efficiency) scores which are greater than or equal to those obtained using the CRS model. (Coelli.T. & Prasad Rao, et.al (1998)) and Banker & Charnes. et.al (1984).

Scale Efficiency (SE)

It is the ratio of CRS to VRS, obtained in technical efficiencies of DMUs. But it will not disclose direction of DMUs in case of returns to scale.

Cost Efficiency (CE)

It is the ratio of cost to output. It is based on the efficiency formula and has many industry specific variants with an objective of reaching lowest cost. It is a ratio of operating expenses to revenues. In the denominator from revenues, current year provisions created for NPAs etc.,., need to be deducted. Banks always thrive to be competitive in this area by adopting innovative processes to reduce the cost. So that they can achieve lower ratios, which is always ideal for their operations.

Allocative Efficiency (AE)

It is the firm's ability to use inputs in best optimal proportions with reference to their prices. As firm's objective is to maintain lower cost efficiencies, which will have a significant impact on allocative efficiency. As allocative efficiency examines the proportion of cost efficiency in total efficiency.

Results and Discussion

This section presents the results and discussions in two parts. First part of results and discussions presents the details of exposures of banks off balance sheet items in terms of foreign exchange contracts, guarantees, acceptance and endorsements etc., Second part of the results and discussions presents the results of Data Envelopment Analysis (DEA) of banks with various efficiency parameters by applying Input Oriented Model.

First section presents a peripheral view of Off balance sheet exposures of select banks for a period of 5 years ranging from 2013 to 2017. Finally incremental change between public and private sector banks exposure towards various off balance sheet items discussed in this section.

Table -1 - Off-Balance Sheet Exposures of Select Private Sector Banks

(Rs. in millions)

Particulars	2017	2016	2015	2014	2013
Foreign exchanges contracts	2,150,319,165	2,388,357,249	2,474,786,082	1,820,734,736	1,745,590,070
Guarantees	348,275,000	278,254,102	239,060,215	208,399,073	189,242,572
Acceptance, Endorsement etc.	203,608,834	180,489,653	165,881,858	119,546,526	125,046,866
Total	**2,702,202,998**	**2,847,101,003**	**2,879,728,155**	**2,148,680,335**	**2,059,879,509**

Table 1 presents the off balance sheet exposures of select private sector banks for a period of 5 years ranging from 2013 to 2017, as per the schedule 12 of banks financial statements. It can be evident that in the year 2015 banks took highest exposure to off balance sheet items in the area of foreign exchange contracts, compared with the rest of the two items. It is one of potential sources of credit risk, banks will face in the financial markets.

Table -2 - Off-Balance Sheet Exposures of Select Public Sector Banks

(Rs. in millions)

Particulars	2017	2016	2015	2014	2013
Foreign exchanges contracts	413,039,738	119,075,640	249,159,994	878,217,266	72,584,035
Guarantees	82,499,788	18,967,960	14,795,637	184,987,630	25,339,493
Acceptance, Endorsement etc.	34,621,805	8,432,450	7,522,969	104,185,653	7,538,973
Total	**530,161,331**	**146,476,050**	**271,478,600**	**1,167,390,548**	**105,462,501**

Table 2 presents the off balance sheet exposures of select public sector banks for a period of 5 years ranging from 2013 to 2017, as per the schedule 12 of banks financial statements. It can be evident that in the year 2015 banks took highest exposure to off balance sheet items in the area of foreign exchange contracts, compared with the rest of the two items. It is one of potential sources of credit risk, banks will face in the financial markets as well as an indication for business growth in foreign contracts.

Table -3 - Incremental Off Balance Sheet Exposure of Indian Commercial Banks (Public & Private)

(Rs. in millions)

Bank Group	Forex contract	Guarantees	Acceptances, Endorsement's etc	Total	Ratio
private	2,115,957,460	252,646,192	158,914,747	2,527,518,400	0.974225
public	346,415,335	65,318,101	32,460,370	444,193,806	0.715823
Total	**2,462,372,795**	**317,964,294**	**191,375,117**	**2,971,712,206**	**0.064399**

Table 3 presents Incremental Off balance sheet exposures and it can be inferred from the results that private sector commercial banks has a ratio of 0.97 significantly higher off-balance sheet exposures as compared to the public sector banks with a ratio of 0.71. It indicates that private banks are accepting higher risk levels and year on year entering into new derivative contracts.

as the ratio for private sector banks is 0.97 which highest than public sector banks whose ratio is 0.71.

Results of Data Envelopment Analysis (DEA)

This section presents the results of data envelopment analysis for investigating the technical efficiency of banks in table 4 & table 5. Technical efficiency of banks examined in terms of Variable Returns to Scale (VRS), Constant Returns to Scale (CRS), Scale Efficiency (SE), and Returns to Scale, Average Efficiency. Technical Efficiency of public and private sector banks examined independently on a year on year basis from 2013 to 2017.

Table -4 - Technical Efficiency (TE) of Private Sector Banks

2013					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	HDFC	1.00000	1.00000	1	constant
2	ICICI	1.00000	1.00000	1	constant
3	KOTAK	1.00000	1.00000	1	constant
4	CUB	1.00000	0.05211	0.052111089	Increasing
5	AXIS	1.00000	0.38069	0.380690177	Increasing
2014					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	HDFC	1.00000	1.00000	1	constant
2	ICICI	1.00000	1.00000	1	constant
3	KOTAK	1.00000	1.00000	1	constant
4	CUB	1.00000	1.00000	1	constant
5	AXIS	1.00000	1.00000	1	constant
2015					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	HDFC	1.00000	1.00000	1	constant
2	ICICI	1.00000	1.00000	1	constant
3	KOTAK	1.00000	1.00000	1	constant
4	CUB	1.00000	1.00000	1	constant
5	AXIS	1.00000	1.00000	1	constant
2016					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	HDFC	1.00000	1.00000	1	constant
2	ICICI	1.00000	1.00000	1	constant
3	KOTAK	1.00000	1.00000	1	constant
4	CUB	1.00000	1.00000	1	constant
5	AXIS	1.00000	1.00000	1	constant

2017					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	HDFC	1.00000	1.00000	1	constant
2	ICICI	1.00000	1.00000	1	constant
3	KOTAK	1.00000	1.00000	1	constant
4	CUB	1.00000	1.00000	1	constant
5	AXIS	1.00000	1.00000	1	constant

Table -5 - Technical Efficiency of Public Sector Banks

2013					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	SBI	1.00000	1.00000	1	Constant
2	CANARA	1.00000	1.00000	1	Constant
3	INDIAN	1.00000	1.00000	1	Constant
4	ANDHRA	1.00000	1.00000	1	Constant
5	ORIENTAL	1.00000	1.00000	1	Constant
2014					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	SBI	1.00000	1.00000	1	Constant
2	CANARA	1.00000	1.00000	1	Constant
3	INDIAN	1.00000	1.00000	1	Constant
4	ANDHRA	1.00000	1.00000	1	Constant
5	ORIENTAL	1.00000	1.00000	1	Constant
2015					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	SBI	1.00000	1.00000	1	constant
2	CANARA	1.00000	1.00000	1	constant
3	INDIAN	1.00000	1.00000	1	constant
4	ANDHRA	1.00000	1.00000	1	constant
5	ORIENTAL	1.00000	1.00000	1	constant

2016					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	SBI	1.00000	1.00000	1	constant
2	CANARA	1.00000	1.00000	1	constant
3	INDIAN	1.00000	1.00000	1	constant
4	ANDHRA	1.00000	1.00000	1	constant
5	ORIENTAL	1.00000	1.00000	1	constant
2017					
		Input-Oriented	Input-Oriented	Scale of efficiency	Returns to scale
		VRS	CRS		
DMU No.	DMU Name	Efficiency	Efficiency		
1	SBI	1.00000	1.00000	1	constant
2	CANARA	1.00000	1.00000	1	constant
3	INDIAN	1.00000	1.00000	1	constant
4	ANDHRA	1.00000	1.00000	1	constant
5	ORIENTAL	1.00000	1.00000	1	constant

During the study period it is observed that DMUs exhibited constant efficiency in all the parameters throughout the study period, except in the year 2013 for two private sector banks deviations are evident and pertinent in their efficiency due to their exposure in off balance sheet transactions.

Input Oriented CRS Efficiency of Private Sector banks reveled that in the year 2013 except City Union Bank (CUB), AXIS Bank, rest of all the private sector banks included in the study viz., HDFC Bank, Kotak Mahindra Bank, ICICI Bank have perfect score of 1. Whereas for CUB, CRS score is 0.05211 indicating a concrete scope for further improvement and this low score is due to their size operations which are limited in scope. This can overcome through strategies like branch expansion strategies in a focused way targeting focused customers and business houses. In case of AXIS Bank CRS Score is 0.38069, it is also indicating a scope for further improvement and in this case it is due to their exposures in various transactions, especially foreign exchange contracts increased the credit risk of the banks.

Bankwise Average Efficiency (AE) Scores

In this section bank wise average efficiency scores are estimated year wise for both public and private sector banks. In case of private sector banks (table-6)Kotak Bank maintained highest average efficiency during the study period and then HDFC Bank in the second place. From table 6 it can be evident that cost efficiency and allocate efficiency wise, in both the parameters, AXIS bank is maintaining a lower cost efficiency per rupee revenue generated and incurring lower cost to produce specified level of output, in the business on a year on year basis of analysis. In case of CUB also exhibiting lower cost efficiency and allocative efficiency, this is due to its limited size of operations.

Table -6 - Private Sector Banks Average Efficiency

2013			
Bank Name	TE	CE	AE
HDFC	1	0.32	0.320438
ICICI	1	0.22	0.224897
KOTAK	1	0.61	0.608831
CUB	1	0.17	0.170965
AXIS	1	0.15	0.151067
2014			
Bank Name	TE	CE	AE
HDFC	1	0.29	0.293024
ICICI	1	0.23	0.233347
KOTAK	1	0.61	0.608831
CUB	1	0.19	0.188387
AXIS	1	0.16	0.158643
2015			
Bank Name	TE	CE	AE
HDFC	1	0.29	0.287715
ICICI	1	0.23	0.234173
KOTAK	1	0.58	0.57999
CUB	1	0.19	0.192237
AXIS	1	0.16	0.157125
2016			
Bank Name	TE	CE	AE
HDFC	1	0.28	0.282322
ICICI	1	0.24	0.240495
KOTAK	1	0.53	0.533981
CUB	1	0.19	0.189433
AXIS	1	0.15	0.149571
2017			
Bank Name	TE	CE	AE
HDFC	1	0.28	0.283209
ICICI	1	0.27	0.272453
KOTAK	1	0.64	0.638115
CUB	1	0.22	0.217081
AXIS	1	0.17	0.167411

Table -7 - Public Sector Banks Average Efficiency

2013			
Bank Name	TE	CE	AE
SBI	1	0.31	0.314444
CANARA	1	0.77	0.768795
INDIAN	1	0.20	0.198007
ANDHRA	1	0.16	0.157804
ORIENTAL	1	0.15	0.150534
2014			
Bank Name	TE	CE	AE
SBI	1	0.34	0.335174
CANARA	1	0.77	0.773831
INDIAN	1	0.19	0.185679
ANDHRA	1	0.16	0.161564
ORIENTAL	1	0.15	0.153379
2015			
Bank Name	TE	CE	AE
SBI	1	0.35	0.352083
CANARA	1	0.78	0.779116
INDIAN	1	0.18	0.177308
ANDHRA	1	0.17	0.167359
ORIENTAL	1	0.15	0.149215
2016			
Bank Name	TE	CE	AE
SBI	1	0.34	0.336791
CANARA	1	0.78	0.778217
INDIAN	1	0.20	0.196716
ANDHRA	1	0.17	0.165891
ORIENTAL	1	0.17	0.172433
2017			
Bank Name	TE	CE	AE
SBI	1	0.38	0.378785
CANARA	1	0.76	0.76148
INDIAN	1	0.21	0.209282
ANDHRA	1	0.19	0.191486
ORIENTAL	1	0.19	0.190252

Table-7 presents the results of public sector banks average efficiency on a year on year basis. It can be observed that Canara Bank maintained highest average efficiency and then SBI stood in second place. In terms of technical efficiency almost all the banks both public and private banks maintained good score of 1. Another significant parameter that drives the business of banking companies is its cost efficiency and allocative efficiency. Table -7 exhibits the results of both these parameter's, on the basis of this, it can be find out that Andhra Bank and Oriental Bank of Commerce (OBC), demonstrating lower cost efficiency and lesser allocative efficiency in producing given level output.

Research Findings

VRSdiscloses that average technical efficiency score for public and private sector banks is 1, which implies that on an average public & private sector banks have constant returns to scale. Same way CRS indicates the average efficiency score is 1, which is similar to mean efficiency score under VRS.

In addition to its bank wise average efficiency scores i.e., technical efficiency, cost efficiency and allocative efficiency for each of the individual public and private sector banks in year wise for five years were considered for in-depth analysis of efficiency of banks. From the calculation we can find relative efficiencies of each of the private & public sector banks each year for five years. It is found that there was a strong positive relationship between the study variables in case of public sector banks. It is also examined that that input variables are significantly affecting the interest of the public sector banks.

Conclusion

DEA algorithm assigns efficiency scores to all identified DMUs on a scale of zero to 100%, where each unit accomplishment matches to 100% efficiency score, called as efficient. The study revealed that, either in single or multiple input-output models, banks with large size operations can sustain their efficiency in the long run and they can respond to the changes dynamically. The empirical results of the study revealed that banks with heavy in size both in terms of operations and profits likely to adopt routine procedures for investments in the areas like technologies (Houssine & Hamed (2017).

Recommendations

This paper clearly disclosed the issue of size of banks plays vital role in sustaining the efficiency in the global financial markets, towards this end Government of India, initiatives like consolidation of banks in the form of mergers lead to increase their efficiency in all parameters. The study recommends to continue this exercise, so that Indian Commercial Banks will stand up to challenges in the global financial markets. Cost and Profitability are the two key parameters for any business, in order to sustain their operations in the long run and develop healthy competition between private and public. Traditionally public sector banks able to manage these efficiencies discussed in the paper through their size of operations, but today that was vanished because of NPAs, so evolve as a strong player the paper recommends that banks need to heavily concentrate on these efficiencies on time to time basis.

Scope for Further Research

The study can be further extended to innovations in DEA methodologies viz., Network based models, Nash bargaining game methodologies, Slacks based models, and Directional distance based models for measuring bank efficiency. The study can be further extended to insurance companies,

financial services companies, mutual fund companies, etc., for examining various efficiencies. The study can be further extended to issues like managerial compensations, superior compensations etc., and its relationship with efficiency score, because these are usually the control variables, so defiantly these areas will provide a better understating of DEA.

Limitations

Efficiency related studies usually examines two types viz., Relative and Absolute Efficiency. This paper examined the efficiency of banking units based on the criteria of performance related ratios and arrived the conclusions through a process of comparisons each unit within the group against a set criteria, which is a relative efficiency. But the limitation of DEA is it is not estimating the absolute efficiency of the banking units. DEA technique uses non parametric approach and is based on extreme points, i.e. compares the units with best performer, as a result as and when the size of the data increases, the technique may lead to measurement errors and noise in data. There are different criteria's available in the literature for inclusion and exclusion of a unit and considering the same unit as DMU.

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