IMPACT OF INFORMATION TECHNOLOGY (IT) INVESTMENTS ON THE COST EFFICIENCY OF INDIAN BANKING SECTOR - A STOCHASTIC FRONTIER APPROACH (SFA)

S. T. Surulivel [1], B. Charumathi [2]
[1]Senior Asst. Professor, School of Management
SASTRA University, Thanjavur, Tamilnadu, India
E-mail: surulivel_st@yahoo.com
[2] Associate Professor, Department of Management Studies (DMS)
School of Management, Pondicherry University
Pondicherry, Tamilnadu, India

Abstract

This research study explores the Cost efficiency of Indian banking sector by employing Stochastic Frontier Approach (SFA). This paper empirically evaluated the impact of Information Technology (IT) on the Cost efficiency of the Indian banks .The present study is based on panel data over the period of 2009-2013. For this paper 77 banks of India are being considered. This paper identifies the average cost efficiency of Indian banks found to be 61 percent over the entire period of study.

The findings of this paper suggest that to some extent IT impact the cost efficiency of Indian banks. There is significant difference among Indian banks on their cost inefficiency in bank-wise. There is no significant difference among Indian banks on their cost inefficiency in year-wise. The difference in cost inefficiency between the best and worst performance banks is significantly reduced by 78.8% for the study period by Information technology investments. Thus, Information Technology contributes to cost efficiency to Indian banking industry.

Keywords: Information Technology (IT), Indian Banks, Cost efficiency, Stochastic Frontier Approach (SFA), cost efficiency.

JEL Classification: M15, L25 AND G21.

INTRODUCTION

Banking system is the backbone of any economy. The growth of various banking technologies changed the nature and functioning of commercial banks all over the world.

Banking technology is defined as the information and communication technologies used by banks to provide various services to its customers in a secure and reliable way in an electronic platform. In India, the IT has brought uprising in the functioning of the banks. The level and utilization of IT depends upon the investment in technology.

Banks in India have been investing and continued to invest enormous amount of funds on computer and related technologies expecting substantial payoff. In the present day rigorous banking environment, a cost benefit analysis of the investments in IT is bound to be a difficult exercise.

It has been a question whether investments in IT provides efficiency in banking performance. Many scholars failed to identify the relationship between higher IT Investment by banks and their efficiency. So they coined the term “IT Productivity Paradox”.

Frontier efficiency is tool to measure the performance of the banks. If a bank capable of producing a same level output with minimizing the inputs, achieve the cost advantage. It is known as cost efficiency. **Cost efficiency** is a measurement indicates how efficiently a bank can reduce its cost. Sometimes, IT provides cost efficiency to the banks because it can reduce the operating expenses in the long run.

The efficiency Studies of banks divided in to parametric and non-parametric methods. In the parametric methods, the Stochastic Frontier Approach (SFA) was often used. Berger (2003) identified 24 studies used SFA out of the 60 studies in parametric. The translog cost function was the most widely used in the SFA method.

This research paper explores the cost efficiency of Indian banking sector using a Stochastic Frontier Approach (SFA). This paper empirically evaluated the impact of Information Technology (IT) on the cost efficiency of the Indian banking sector .The present study is based on panel data over the period of 2009-2013.

OBJECTIVES OF THE STUDY

This paper consists of the following objectives:

1. To identify the variables influencing cost efficiency of Indian banks.
2. To measure the cost efficiency of various banks in India.
3. To compare the cost efficiency of banks in bank-wise and year-wise.

HYPOTHESIS

H_{01}: Among the bank groups operating in India, there is no significant difference in the

H_{01a}: bank-wise cost efficiency

H_{01b}: year-wise cost efficiency

LITERATURE REVIEW

Rai et al. (1997) identified that IT investments influence the business performance positively.

Lee and Menon (2000) found that higher investment in IT contribute higher efficiency. They employed non parametric approach to analyze the performance of hospitals.

Shao and Lin (2001) identified IT had impact on efficiency. The authors investigated the impact of IT investments to the performance of 370 firms and concluded that there is a impact of IT towards the performance of the firms.

Simon H. Kwan (2004) identified cost efficiency of banks in Hong Kong. He used the SFA and found that the efficiency of banks was in between 16 percent to 30 percent.

Namchul Shin (2006) identified the importance of business value of IT in relation to strategic firm performance to reduce the cost of coordinating business resources across multiple markets.

William et al. (1991) examined technological changes and its impact on output for U.S. commercia1 banks. They suggested that technological change can lower the real costs by 1% per year.

Costas Lapavitsas and Paulo L. Dos Santos (2008) identified the money transaction cost reduced due to investment in IT.

Shirley J. Ho and Sushanta K. Mallick (2008) examined that IT can improve efficiency of banks in two ways. The two ways are known as cost effect and network effect. **Baker and Berenblum (1996),** identified IT is one of the important factor decides the success or failure of organizations.

Morrison and Berndt (1990) identified marginal IT investments provided negative impact to efficiency . They also found that compared to cost, the benefit is lesser and thus provided negative contribution to efficiency.

Kaparakis et al(1994) found the significant negative correlation between cost efficiency and size of the bank and significant positive correlation between efficiency and the ratio of capital to total assets.

Meeusen and vanden Broeck (1977) and **Aigner, Lovell and Schmidt (1977)** provided the fundamental model of stochastic frontier approach. They applied SFA in many studies related to cost efficiency in the banks

Jeffrey et al. (2007) recommended to include off-balance-sheet (OBS) activities in the cost efficiency measurement. **Altinkemer, Kemal, Ozdemir, Zafer (2006)** investigate the reengineering of companies by Information Technology (IT) in their business processes improved their productivity .

Claudia Girardone et al(2004) analyzed the cost efficiency of banks in Italy. They used a Fourier-flexible(FF)model of stochastic cost function to estimate the cost efficiency. They found cost inefficiency decreased over the study period.

Laurent Weill (2009) employed three efficiency approaches SFA, DFA and DEA. The authors measured the cost efficiency of banks and found some similarities exist between the approaches.

Sealey and Lindley (1977) introduced variables (Input and Output) for intermediation approach. The output variables are Y1 = loans, Y2 = investment. The inputs are prices of labor, physical capital and borrowed funds.

Altunbas et al. (2000) identified proxy variables to measure the price of labor, price of physical capital and price of borrowed funds.

RESEARCH METHODOLOGY

This study is an empirical study to identify the Information Technology (IT) impact to cost efficiency of Indian banks. Cost efficiency is measured using the translog cost function and employed stochastic cost frontier approach. A panel data were used and the sample includes 77 banks in India.

Cost inefficiency was estimated by using Frontier 4.1. To estimate the cost function the Maximum Likelihood (ML) estimator is used. The likelihood ratio test is used to identify the suitability of a cost function.

For the estimation of the cost function and thus measuring the cost efficiency of banks, the below relationship has to be assumed.

$$\ln C_{it} = f(y_{it}, w_{it}; \beta) + e_{it} \quad \text{----- (1)}$$

where

C_{it} = Total cost of bank i,

y_{it} = Natural logarithm of the output,

w_{it} = Natural logarithm of input prices,

β = The unknown parameter to be estimated.

e_{it} is a one-sided error term . The error term is used to measure effects of inefficiency. The general assumption is, e_{it} is half normally distributed.

Translog cost function is used for efficiency estimation in many studies. The translog cost function was first introduced by Cristensen et al. (1971). Hence, this study used translog cost function in the place of standard production model.

For the definition of input and output variables ,this study use intermediation approach consider three inputs (labour, deposits and physical capital) and two outputs (loans and Investments).

This study used three basic inputs for the banking sector .

The input prices are defined as

P_1= Input Price of labour (Salaries and employee benefits/ the total number of the employees)

P_2 = Input Price of deposit (Total interest expenses of deposits/ saving deposits+ other deposits) and

P_3 = Input Price of Physical capital (Physical capital expenses/Physical capital)

The outputs used include loans & advances and investment. Where Y_1 = Loans and Advances; Y_2 = Investment.

The stochastic translog cost model is expressed as follows:

$$C = \beta_0 + \sum_{n=1}^{N} \beta_{yn} y_n + \sum_{m=1}^{M} \beta_{pm} p_m + \frac{1}{2}\left(\sum_{n=1}^{N}\sum_{l=1}^{N} \beta_{yn\,yl} y_n y_l + \sum_{m=1}^{M}\sum_{k=1}^{M} \beta_{pm\,pk} p_m p_k \right) + \sum_{n=1}^{N}\sum_{m=1}^{M} \beta_{yn\,pm} y_n p_m + V_{it} + U_{it} \quad \text{---(2)}$$

Where

y_n = N outputs in logs

$p_{m=}$ Prices of the M inputs in logs.

Standard symmetry and linear homogeneity conditions are imposed. For simplicity notations ‘i’(for bank) and‘t’ (for time) have been omitted in the model.

U_{it} is the cost inefficiency measures indicates how the costs of a bank ‘i’ at time‘t’ are to the banks on the cost efficient frontier, producing the same output.

V_{it} stands for the usual error term.

The variables for analyzing the If

U_{it} = zero,

Ci*(Frontier Cost Function) = f (yi, xi, β) and () of bank

CE (Cost efficiency)= $CE = C_i / C_i^* = f(y_i, x_i, \beta) \exp(U_{it}) / f(y_i, x_i, \beta)$

$$\mathbf{CE = \exp(U_{it})} \quad \mathbf{(3)}$$

Cost inefficiency estimation from OLS, is then regressed with Information Technology (IT) investment by maximum likelihood model.(Technical efficiency) is as:

$$U_{it} = \Delta_0 + \Delta_1 Z_{it} + e_{it} \quad (4)$$

Here

Δ_0 = Intercept;

Δ_1 = maximum likelihood regression Coefficient;

Z_{it} = IT investment by the bank i and the year t; and

e_{it} is a error term.

TABLE – 1
Input and Output Variables

Variable	Variable name	Definition
C	Total costs	Interest expenses and operating expenses
Π	Pretax Profit	Income before taxation
OUTPUT VARIABLES		
Y_1	Loans and Advances	Loan
Y_2	Investments	Investments
PRICES OF INPUT OF VARIABLES		
P_1	Input Price of labour	Salaries and employee benefits/ the total number of the employees
P_2	Input Price of deposit	Total interest expenses of deposits/ saving deposits+ other deposits
P_3	Input Price of Physical capital	Physical capital expenses/Physical capital
REGRESSION VARIABLE(ML estimation)		
Z	Information Technology Investment	Various Expenses involved in IT

Note : Variables identified and grouped by the researchers.

Frontier efficiency is tool to measure the performance of the banks. If a bank capable of producing a same level output with minimizing the inputs, achieve the cost advantage. It is known as cost efficiency. **Cost efficiency** is a measurement indicates how efficiently a bank can reduce its cost. Sometimes, IT provides cost efficiency to the banks because it reduces the operating expenses in the long run.

COST EFFICIENCY OF TOTAL INDIAN BANKING INDUSTRY

Table 2 provides SFA -Cost Translog Estimates for total Banking Industry. For total banking industry, 77 banks are considered. The negative sign in the significant coefficients indicate that, the respective variables try to reduce the cost inefficiency. So, the respective variables increase the cost efficiency of banks.

The Input and Output variables which increased the cost efficiency of banks are:

Loans and Advances [-6.332 (-2.155)** significant at 5 %] indicate that banks are effectively handling their loan portfolio for the period 2009-2013, Deposits [-5.15(-3.724)* significant at 1 %]indicate the Interest expenses are reduced significantly even though there is an increase in deposits of banks for the period 2009-2013. The Deposit is increased by 117.749 %. This reduction is due to interest rate reduction.

The Input and Out put variables which reduced the cost efficiency of Indian banks are:

Labour [5.358 (2.049) ** significant at 5 %] indicate the labour expenses are increased significantly which leads to cost inefficiency in banks for the study period. This is due to the increase in the Number of Employee. For total banking industry , Number of Employees is increased by 9.88 % for the study period.

Physical capital [6.796(6.636)* significant at 1 %] indicate the rent, insurance and maintenance expenses are increased significantly which leads to cost inefficiency in banks for the period.

Table 2
SFA -COST TRANSLOG ESTIMATES -TOTAL BANKING INDUSTRY

		OLS		CORRECTED OLS	ML	
VARIABLES	VARIABLES	COEFFICIENT	t VALUE	COEFFICIENT	COEFFICIENT	t VALUE
beta0	Intercept	0	0.004	-0.196	-0.162	-3.635*
beta1	Y1	-2.601	-0.552	-2.601	**-6.332**	**-2.155****
beta2	Y2	-1.832	-0.378	-1.832	-2.444	-1.345
beta3	P1	**10.542**	**2.301****	10.542	**5.358**	**2.049****
beta4	P2	-3.562	-1.578	-3.562	**-5.15**	**-3.724***
beta5	P3	**11.068**	**2.287****	11.068	**6.796**	**3.636***
beta6	Y1*Y1	4.781	1.541	4.781	**4.581**	**3.469***
beta7	Y1*Y2	1.212	0.356	1.212	-0.967	-0.951
beta8	Y2*Y2	0.429	0.124	0.429	**1.575**	**2.38****
beta9	P1*P1	-2.236	-0.628	-2.236	**-2.518**	**-2.52****
beta10	P1*P2	-0.088	-0.952	-0.088	-0.045	-0.602
beta11	P1*P3	-4.567	-1.003	-4.567	-0.067	-0.044
beta12	P2*P2	1.908	1.573	1.908	**2.686**	**3.643***
beta13	P2*P3	-0.234	-1.086	-0.234	**-0.291**	**-2.173***
beta14	P3*P3	-0.073	-0.028	-0.073	**-2.956**	**-2.759***
beta15	Y1*P1	-4.824	-1.503	-4.824	-0.36	-0.247
beta16	Y1*P2	-0.086	-0.351	-0.086	0	-0.002
beta17	Y1*P3	-3.14	-1.042	-3.14	-1.221	-1.248
beta18	Y2*P1	3.341	0.952	3.341	0.113	0.088
beta19	Y2*P2	0.088	0.35	0.088	0.046	0.22
beta20	Y2*P3	-2.86	-0.694	-2.86	0.807	0.582
delta0					-4.282	-4.985*
delta1					**-0.788**	**-13.003***
sigma-squared		0.085		0.119	**1.766**	**7.54***
Gamma				0.51	**0.987**	**347.614***
log likelihood function		**-60.49**			**-23.64**	
LR test of the one-sided error					73.7	

Note : Computed using FRONTIER 4.1

* 1% significance level, ** 5 % significance level, *** 10% significance level

The log –likelihood function for full stochastic model where inefficiency is assumed to be half-normal is calculated to be -23.64 and the value for OLS function is -60.49, which is less than the full frontier model. LR test statistics for testing the absence of the technical inefficiency effect from the frontier is calculated to be 73.7. This value is significantly higher than the critical value (2.706 at 5% level of significance, Kodde and Palm (1986) for df equal to 1).

The sigma-square is 1.766 and significant at 1% level, indicating the correctness of the specified assumptions of the distribution of the composite error term. The gamma value is 0.987 and significant at the 1% level. It is an indication that 98.7 % variation in output is attributed to bank specific technical inefficiency and remaining 1.3 % variation in out put is attributed to noise.

The variation in cost efficiency seems to have narrowed over time, as represented by the delta values. The difference in cost inefficiency between the best and worst performance banks is significantly reduced by 78.8% for the study by Information technology investments. This result may be due may be a result of more emphasis being placed on cost efficiency and the effective deployment of technology in banking such as ATMs in place of the more expensive brick and mortar structures.

Table 3 Provides cost inefficiency estimate of total banking industry. For total banking industry, 77 banks are considered. The results show that overall the banks are over 39.7 % inefficient i.e. 60.3% efficient, with Antwerp Diamond Bank N V being the most efficient and Oman International Bank the least. The average inefficiency score for Antwerp Diamond Bank N V is 1.069, implying that its inefficiency is 6.9 % higher than

it should be. For natural log, the most cost efficient firm will have a value of 1, the farther the value from 1, the most cost inefficient the firm is.

TABLE 3
COST INEFFICIENCY ESTIMATE OF TOTAL BANKING INDUSTRY

SL. NO	NAME OF THE BANK	COST INEFFICIENCY ESTIMATE					AVERAGE (BANK WISE)
		2005	2006	2007	2008	2009	
1	Allahabad Bank	1.070	1.078	1.128	1.117	1.186	1.116
2	Andhra Bank	1.129	1.101	1.127	1.172	1.229	1.152
3	Bank of Baroda	1.124	1.133	1.155	1.196	1.246	1.171
4	Bank of India	1.079	1.098	1.129	1.169	1.168	1.129
5	Bank of Maharashtra	1.125	1.120	1.126	1.136	1.143	1.130
6	Canara Bank	1.108	1.145	1.156	1.197	1.163	1.154
7	Central Bank of India	1.128	1.107	1.111	1.145	1.130	1.124
8	Corporation Bank	1.129	1.118	1.135	1.142	1.142	1.133
9	Dena Bank	1.102	1.167	1.168	1.165	1.166	1.154
10	Indian Bank	1.079	1.080	1.116	1.122	1.177	1.115
11	Indian Overseas Bank	1.104	1.101	1.125	1.178	1.250	1.152
12	Oriental Bank of Commerce	1.077	1.107	1.165	1.249	1.206	1.161
13	Punjab and Sind Bank	1.192	1.112	1.137	1.144	1.137	1.145
14	Punjab National Bank	1.086	1.132	1.248	1.122	1.194	1.156
15	Syndicate Bank	1.101	1.110	1.134	1.190	1.271	1.161
16	UCO Bank	1.091	1.120	1.148	1.194	1.219	1.154
17	Union Bank of India	1.088	1.116	1.154	1.121	1.142	1.124
18	United Bank of India	1.099	1.082	1.087	1.082	1.110	1.092
19	Vijaya Bank	1.068	1.129	1.122	1.123	1.276	1.144
20	State Bank Of Bikaner & Jaipur	1.175	1.162	1.190	1.207	1.312	1.209
21	State Bank Of Hyderabad	1.092	1.088	1.135	1.132	1.126	1.114
22	State Bank Of India	1.112	1.166	1.180	1.129	1.147	1.147
23	State Bank Of Indore	1.076	1.206	1.187	1.173	1.274	1.183
24	State Bank Of Mysore	1.134	1.176	1.146	1.193	1.154	1.160
25	State Bank Of Patiala	1.108	1.102	1.125	1.128	1.160	1.125
26	State Bank Of Saurashtra	1.167	1.137	1.120	1.216	1.155	1.159
27	State Bank Of Travancore	1.125	1.097	1.143	1.182	1.198	1.149
28	Bank Of Rajasthan Ltd.	1.105	1.158	1.125	1.129	1.097	1.123
29	Catholic Syrian Bank Ltd.	1.359	1.237	1.214	1.267	1.273	1.270
30	City Union Bank Ltd.	1.167	1.159	1.173	1.258	1.147	1.181
31	Dhanalakshmi Bank Ltd.	1.268	1.151	1.242	1.258	1.112	1.206
32	Federal Bank Ltd.	1.162	1.103	1.174	1.203	1.232	1.175
33	I N G Vysya Bank Ltd.	1.217	1.276	1.255	1.214	1.224	1.237
34	Jammu & Kashmir Bank Ltd.	1.055	1.057	1.121	1.138	1.176	1.109
35	Karnataka Bank Ltd.	1.090	1.069	1.137	1.150	1.113	1.112
36	Karur Vysya Bank Ltd.	1.121	1.121	1.147	1.163	1.154	1.141
37	Lakshmi Vilas Bank Ltd.	1.187	1.149	1.275	1.259	1.302	1.234
38	Nainital Bank Ltd.	1.095	1.211	1.208	1.181	1.187	1.177
39	Ratnakar Bank Ltd.	1.169	1.215	1.178	1.231	1.224	1.203
40	S B I Commercial & International Bank Ltd.	1.383	1.218	1.110	1.105	1.159	1.195
41	South Indian Bank Ltd.	1.161	1.253	1.216	1.144	1.154	1.186
42	Tamilnad Mercantile Bank Ltd.	1.176	1.103	1.147	1.137	1.165	1.146
43	Axis Bank Ltd.	1.056	1.061	1.088	1.159	1.206	1.114
44	Centurion Bank Of Punjab Ltd.	1.266	1.479	1.385	1.164	1.187	1.296
45	Development Credit Bank Ltd.	1.375	1.478	1.226	1.351	1.463	1.379
46	H D F C Bank Ltd.	1.062	1.069	1.184	1.173	1.342	1.166
47	I C I C I Bank Ltd.	1.104	1.104	1.216	1.179	1.183	1.157
48	Indusind Bank Ltd.	1.158	1.134	1.172	1.274	1.361	1.220
49	Kotak Mahindra Bank Ltd.	1.136	1.298	1.101	1.144	1.206	1.177
50	Yes Bank Ltd.	1.041	1.073	1.107	1.229	1.101	1.110
51	A B Bank Ltd.	2.512	2.144	2.824	2.345	2.975	2.560

52	A B N-Amro Bank N.V.	1.448	1.408	1.629	1.337	1.945	1.553
53	Abu Dhabi Commercial Bank	2.470	3.872	2.133	2.175	1.259	2.382
54	American Express Bank Ltd.	1.654	1.514	1.371	1.152	1.187	1.376
55	Antwerp Diamond Bank N V	1.038	1.100	1.087	1.069	1.052	1.069
56	B N P Paribas	1.187	1.318	1.714	1.234	1.247	1.340
57	Bank International Indonesia	1.075	6.238	3.206	1.187	1.187	2.579
58	Bank Of Bahrain & Kuwait Bsc	1.713	1.748	2.168	1.528	1.972	1.826
59	Bank Of Ceylon	1.686	1.859	1.797	1.682	1.811	1.767
60	Bank Of Nova Scotia	1.198	1.088	1.143	1.091	1.253	1.155
61	Bank Of Tokyo-Mitsubishi U F J Ltd.	1.536	1.216	1.122	1.192	1.301	1.273
62	Barclays Bank Plc.	5.428	7.624	2.326	1.771	1.637	3.757
63	Calyon Bank	1.243	1.491	1.382	1.398	1.076	1.318
64	Chinatrust Commercial Bank	1.187	1.187	1.187	1.187	1.187	1.187
65	Citibank N A.	1.471	1.295	1.453	1.606	1.660	1.497
66	D B S Bank Ltd.	1.041	1.356	1.928	1.111	1.086	1.304
67	Deutsche Bank A G	1.594	1.927	1.268	1.209	1.648	1.529
68	Hongkong & Shanghai Banking Corpn. Ltd.	1.159	1.178	1.401	1.518	1.408	1.333
69	J P Morgan Chase Bank, National Association	2.063	1.615	1.083	1.165	1.364	1.458
70	J S C Vtb Bank	1.187	1.187	1.187	1.187	1.193	1.189
71	Krung Thai Bank Public Co. Ltd.	1.104	2.306	1.671	2.025	2.538	1.929
72	Mizuho Corporate Bank Ltd.	1.027	1.175	1.115	1.183	1.305	1.161
73	Oman International Bank	7.217	1.898	2.647	25.482	2.165	7.882
74	Shinhan Bank	1.187	1.223	1.292	1.562	1.268	1.307
75	Societe Generale	1.036	1.074	1.185	1.099	1.116	1.102
76	Sonali Bank	1.187	1.187	1.187	1.187	1.187	1.187
77	Standard Chartered Bank	1.193	1.324	1.487	1.139	1.791	1.387
	AVERAGE (YEAR WISE)	1.360	1.429	1.326	1.567	1.307	1.397

Note : Computed using FRONTIER 4.1

TABLE 4
Analysis of Variance (Bank-wise)

Source of Variation	SS	Df	MS	F	F crit
Between banks	276.6131	76	3.63964644	2.4187	1.328
Within banks	463.469513	308	1.50477114		
Total	740.0826429	384			

Note : Computed using SPSS 16.0

Table 4, gives the results based on ANOVA test. As the calculated value is (2.4187) higher than that the table value (1.328), the null hypothesis (H_{01a}) is rejected. Thus, , there is significant difference among Indian banks on their cost inefficiency in bank-wise.

TABLE – 5
Analysis of Variance (Year -wise)

Source of Variation	SS	Df	MS	F	F crit
Between the Year	3.45863	4	0.8646	0.4518	2.3951
Within the Year	736.6684	385	1.91342		
Total	740.127	389			

Note : Computed using SPSS 16.0

Table 5 gives the results based on ANOVA test. As the calculated value is (0.45189) lesser than the table value (2.3951), the null hypothesis (H_{01b}) is accepted. Thus, there is no significant difference among Indian banks on their cost inefficiency in year-wise.

RESULT AND DISCUSSION

This paper identifies the average cost efficiency of Indian banks found to be 61 percent over the entire period of study. The findings of this paper suggest that to some extent IT impact the cost efficiency of Indian public sector banks.

Loans and Advances [-6.332 (-2.155)** significant at 5 %] indicate that banks are effectively handling their loan portfolio for the period 2009-2013.

Deposits [-5.15(-3.724)* significant at 1 %]indicate the Interest expenses are reduced significantly even though there is an increase in deposits of banks for the period 2009-2013.

The Deposit is increased by 117.749 %. This reduction is due to interest rate reduction.

Labour [5.358 (2.049) ** significant at 5 %] indicate the labour expenses are increased significantly which leads to cost inefficiency in banks for the study period. This is due to the increase in the Number of Employee. For total banking industry , Number of Employees is increased by 9.88 % for the study period.

Physical capital [6.796(6.636)* significant at 1 %] indicate the rent, insurance and maintenance expenses are increased significantly which leads to cost inefficiency in banks for the period.

There is significant difference among Indian banks on their cost inefficiency in bank-wise.

There is no significant difference among Indian banks on their cost inefficiency in year-wise

The difference in cost inefficiency between the best and worst performance banks is significantly reduced by 78.8% for the study period by Information technology investments. Thus, Information Technology contributes to cost efficiency to Indian banking industry.

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