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Impact of Information Technology (IT) Investments on the Cost Efficiency of Indian Private Sector Banks-A Stochastic Frontier Approach (SFA)

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Abstract: This research study explores the Cost efficiency of Indian Private Sector banks by employing Stochastic Frontier Approach (SFA). This paper empirically evaluated the impact of Information Technology (IT) on the Cost efficiency of the Indian private sector banks .The present study is based on panel data over the period of 2009-2013. For this study, all the 13 old private sector banks and 7 new private sector banks of India are being considered. This study identifies the average cost efficiency of old private sector banks found to be 94.9% and for new private sector banks 82.6% over the entire period of study. The findings of this study suggest that to some extent IT impact the cost efficiency of Indian private sector banks. Some of Old private sector bank cost inefficiency reduced by 28% for the study period by Information Technology (IT) and for New private sector banks cost inefficiency reduced by 11.3% Information Technology (IT). Thus, Information Technology contributes to cost efficiency to both old and new private sector banks.

Keywords: Cost efficiency, Indian private sector banks, Information Technology (IT), Stochastic Frontier Approach (SFA)

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 reduces 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.

Allen (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 Private Sector banks using a Stochastic Frontier Approach (SFA).

This study empirically evaluated the impact of Information Technology (IT) on the cost efficiency of the Indian private sector banks. The present study is based on panel data over the period of 2009-2013.

OBJECTIVES OF THE STUDY

This study consists of the following objectives:

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

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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 an impact of IT towards the performance of the firms.

Simon (2001) identified cost efficiency of banks in Hong Kong. He used the SFA and found that the efficiency of banks was in between 16 to 30%.

Namchul (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 and Stephen (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 and Dos-Santos (2008) identified the money transaction cost reduced due to investment in IT.

Shirley and Sushanta (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 Van Den-Broeck (1977) and Aigner *et al*. (1977) provided the fundamental model of stochastic frontier approach. They applied SFA in many studies related to cost efficiency in the banks.

Jeffrey and Thomas (2002) recommended including Off-Balance-Sheet (OBS) activities in the cost efficiency measurement.

Altinkemer *et al*. (2006) investigate the reengineering of companies by Information Technology (IT) in their business processes improved their productivity.

Claudia *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 (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.

Lapavitsas and Dos-Santos (2008) argued technological innovation has contributed to recent changes in the conduct and character of banking, but its impact has been contradictory. First, money-dealing transactions have become cheaper, but investment costs have increased and a broader range of services had to be provided. The cost efficiency of banks has not improved.

Yao and Joe (2004) recognized that the link between Information Technology (IT) investment and firm performance is indirect due to the effect of mediating and moderating variables. The IT generates funds from the customer in the forms of deposits. Profits then are generated by using deposits as a source of investment funds.

Barbara and Claudia (2005) identified the impact of the inclusion of these activities varies. Overall, the inclusion of OBS items results in an increase in estimated productivity levels for all countries under study. However, the impact seems to be the biggest on technological change rather than efficiency change.

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 private sector 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 13 old private sector banks and 7 new private sector banks of 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:

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

Variables identified and grouped by the researchers

$$\ln Cit = f(yit,, wit,; \beta)+eit \quad (1)$$

where,
C*it* = Total cost of bank i
yit, = Natural logarithm of the output
wit = Natural logarithm of input prices
β = The unknown parameter to be estimated
e*it* = A one-sided error term

The error term is used to measure effects of inefficiency. The general assumption is, *eit* is half normally distributed.

Translog cost function is used for efficiency estimation in many studies. 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 and advances and investment.

where,
Y_1 = Loans and Advances
Y_2 = Investment.

The stochastic translog cost model is expressed as follows:

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

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.

If
U_{it} = zero
Ci*(Frontier Cost Function) = f (yi, xi, β)
CE (Cost efficiency) =
$CE = C_i / C_i^* = f(y_i, x_i, \beta) \exp(U_{it}) / f(y_i, x_i, \beta)$

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

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
e_{it} = A error term

Table 1 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 OLD PRIVATE SECTOR BANK

Table 2 Provides cost inefficiency estimate of Old private sector bank. For Old private sector bank, 13 banks are considered. Based on the result the banks are 5.1% Cost inefficient i.e., 94.9% Cost efficient. Karnataka Bank Ltd is the most Cost efficient and Catholic Syrian bank Ltd is the least cost efficient. The inefficiency (average) for Karnataka Bank Ltd is 1.026, indicates that its inefficiency is 2.6% higher than its ideal value.

The inefficiency (average) for Catholic Syrian bank Ltd is 1.102, indicates its inefficiency is 10.2% higher than its ideal value. The natural log is used to identify the most cost efficient firm. It will have a value of 1. The farthest value from 1 denotes the extent of cost inefficiency of a bank.

Table 3, Provides SFA-Cost Translog Estimates for Old private sector bank. For Old private sector bank, 13 banks are considered. The negative sign in the significant coefficients indicates that, the respective variables try to reduce the cost inefficiency. So the respective variables increase the cost efficiency of Indian Old private sector bank. . The positive sign in the significant coefficients indicates that, the respective variables try to increase the cost inefficiency. So the

Table 2: Cost inefficiency estimate of old private sector bank

		Cost inefficiency estimate					
SL. no	Name of the bank	2009	2010	2011	2012	2013	Average (bank wise)
1	Catholic Syrian Bank Ltd.	1.292	1.064	1.041	1.030	1.084	1.102
2	City Union Bank Ltd.	1.015	1.040	1.026	1.044	1.078	1.041
3	Dhanalakshmi Bank Ltd.	1.157	1.035	1.058	1.040	1.035	1.065
4	Federal Bank Ltd.	1.165	1.032	1.028	1.026	1.083	1.067
5	I N G Vysya Bank Ltd.	1.134	1.064	1.042	1.051	1.019	1.062
6	Jammu and Kashmir Bank Ltd.	1.036	1.015	1.016	1.035	1.101	1.041
7	Karnataka Bank Ltd.	1.024	1.012	1.037	1.024	1.035	1.026
8	Karur Vysya Bank Ltd.	1.027	1.018	1.042	1.021	1.102	1.042
9	Lakshmi Vilas Bank Ltd.	1.143	1.022	1.045	1.058	1.045	1.063
10	Nainital Bank Ltd.	1.051	1.028	1.028	1.045	1.027	1.036
11	Ratnakar Bank Ltd.	1.031	1.024	1.009	1.087	1.031	1.036
12	South Indian Bank Ltd.	1.060	1.050	1.031	1.029	1.041	1.042
13	Tamilnad Mercantile Bank Ltd.	1.106	1.020	1.038	1.028	1.031	1.045
Average (year wise)		1.095	1.033	1.034	1.040	1.055	1.051

Computed using Frontier 4.1

Table 3: SFA -cost translog estimates -old private sector bank

		OLS			ML	
Variables	Variables	Coefficient	t value	Corrected OLS coefficient	Coefficient	t-value
Beta0	Intercept	0	0.008	-0.055	-0.03	-1.274
Beta1	Y1	5.894	1.705	5.894	7.065	5.899*
Beta2	Y2	3.705	1.27	3.705	1.577	1.208
Beta3	P1	-1.079	-0.356	-1.079	-1.251	-0.996
Beta4	P2	0.74	0.454	0.74	0.83	0.917
Beta5	P3	2.147	0.661	2.147	4.331	3.061*
Beta6	Y1*Y1	-3.778	-1.748***	-3.778	-3.11	-3.323*
Beta7	Y1*Y2	2.699	0.975	2.699	2.109	1.64
Beta8	Y2*Y2	-0.935	-0.426	-0.935	-0.449	-0.468
Beta9	P1*P1	-1.922	-0.898	-1.922	-0.955	-1.121
Beta10	P1*P2	0.008	0.194	0.008	-0.039	-1.449
Beta11	P1*P3	5.031	1.732	5.031	2.281	1.747
Beta12	P2*P2	-0.291	-0.335	-0.291	-0.299	-0.612
Beta13	P2*P3	-0.046	-0.34	-0.046	-0.04	-0.477
Beta14	P3*P3	-1.138	-0.432	-1.138	-0.227	-0.224
Beta15	Y1*P1	0.292	0.102	0.292	-0.33	-0.272
Beta16	Y1*P2	0.063	0.364	0.063	0.073	0.707
Beta17	Y1*P3	-0.851	-0.346	-0.851	-2.098	-1.711
Beta18	Y2*P1	-0.393	-0.145	-0.393	1.265	1.046
Beta19	Y2*P2	-0.053	-0.302	-0.053	-0.071	-0.694
Beta20	Y2*P3	-3.7	-1.265	-3.7	-3.654	-2.96*
Delta0				0	-2.667	-1.381
Delta1				1	0.281	1.6
Sigma-squared		0.005		0.007	0.106	1.371
Gamma				0.69	0.991	127.955*
Log likelihood function		101.14			108.302	
LR test of the one-sided error					14.331	

Computed using FRONTIER 4.1; * 1% significance level; ** 5 % significance level; *** 10% significance level

Table 4: Analysis of variance (Bank-wise)

Source of Variation	SS	Df	MS	F	F-crit
Between banks	0.056817	14	0.004058	0.951145	1.860242
Within banks	0.256009	60	0.004267		
Total	0.312826	74			

Computed using SPSS 16.0

Table 5: Analysis of variance (Year -wise)

Source of variation	SS	Df	MS	F	F-crit
Between the year	0.087217	4	0.021804	6.765267	2.502656
Within the year	0.225609	70	0.003223		
Total	0.312826	74			

respective variables decrease the cost efficiency of Indian Old private sector bank.

The Input and Output variables which increased the cost efficiency are: Joint significance of Deposit and Physical capital [-3.654 (-2.96)* significant at 1%] indicate Old private sector bank are increasing their deposit and reducing the rent expenses to attain the cost efficiency for the period 2009-2013.

The Input and Output variables which reduced the cost efficiency are: Labour [7.065(5.899)* significant at 1%] indicate the labour expenses are increased significantly which leads to cost inefficiency in Old private sector bank. This is due to the Number of Employees.

Number of Employees had improved by 19.83% for the study period. Physical capital [4.331(3.061)* significant at 1%] indicate expenses are increased significantly which leads to cost inefficiency in Old private sector bank.

The log-likelihood function for full stochastic model is calculated to be 108.302 and the value for OLS function is 101.14, which is less than the full frontier model.

LR test statistics for testing the absence of the cost inefficiency from the frontier is calculated to be 14.331. This value is significantly higher than the critical value (2.706 at 5% level of significance, provided by Kodde and Palm (1986) for df equal to 1).

The sigma-square is 0.106 and insignificant, indicating the partial correctness of the composite error term. The gamma value is 0.991 and significant at the 1% level. It is an indication that 99.1% variation in output is attributed to bank specific technical inefficiency and remaining variation 0.9% in output is attributed to noise.

The variation in cost efficiency have decreased over time. It is identified from the delta values. The difference in cost inefficiency between the best practice and worst practice banks is significantly increased by 28% for the period by Information technology.

Thus, some of Old private sector bank cost efficiency reduced by 28% for the study period by Information Technology (IT). The information technology contributes cost efficiency.

Table 4 gives the results based on ANOVA test. As the calculated value is (0.951145) lesser than the table value (1.860242), the null hypothesis (H_{01a}) is accepted.

Thus, there is significant difference among the Indian Old private sector bank in their cost efficiency.

Table 5 gives the results based on ANOVA test. The calculated value is (6.765267) higher than the table value (2.502656), the null hypothesis (H_{01b}) is rejected. Thus, there is significant difference in cost inefficiency among the Indian Old private sector banks in year-wise.

COST EFFICIENCY OF NEW PRIVATE SECTOR BANK

Table 6, Provides cost inefficiency estimate of new private sector bank. For New private sector bank 7 banks are considered. Based on the results, the banks are 17.4% Cost inefficient i.e., 82.6% Cost efficient. Yes Bank Ltd is the most Cost efficient and HDFC Bank Ltd is the least cost efficient.

The average inefficiency score for Yes Bank Ltd Ltd is 1.087, indicates that its inefficiency is 8.8 % higher than its ideal value. The average inefficiency score for H D F C Bank Ltd is 1.304, indicates that its inefficiency is 30.4% higher than its ideal value. The natural log is used to identify the most cost efficient firm. It will have a value of 1. The farthest value from 1 denotes the extent of cost inefficiency of a bank.

Table 7 Provides SFA -Cost Trans log Estimates for New private sector bank. For New private sector bank, 7 banks are considered.

The Input and Output variables which increased the cost efficiency are: Loans and Advances [-11.687 (-12.53)* significant at 1%] indicate, New private sector banks are effectively handling their loan portfolio for the period 2009-2013.Deposit [-7.706(-8.833)* significant at 1%] indicate the Interest expenses are reduced significantly even though there is an increase in deposit. For new private sector Banks, Deposit improved by 182.899% for the study .This reduction is due to interest rate reduction.

Physical capital [-9.233(-9.621)* significant at 1%] indicate the rent expenses are decreased significantly which leads to cost efficiency in New private sector banks. Joint significance of Investments and Physical capital [-2.751 (-3.113) ** significant at 5%] indicate New private sector bank are increasing their Investments and reducing the rent expenses to attain the cost efficiency.

The Input and output variables which reduced the cost efficiency are: Investments [7.098(7.613)* significant at 1%] indicate the improper Investments are increased significantly which leads to cost inefficiency in New private sector bank. Labour [7.168(7.712)* significant at 1%] indicate the labour expenses are increased significantly which leads to cost inefficiency in New private sector bank. For new private sector

Table 6: Cost inefficiency estimate of new private sector bank

SL.no	Name of the bank	Cost inefficiency estimate 2009	2006	2007	2008	2009	Average (bank wise)
1	Axis Bank Ltd.	1.19	1	1.104	1.282	1.288	1.172
2	Development Credit Bank Ltd.	1.449	1.21	1.108	1.093	1.153	1.202
3	H D F C Bank Ltd.	1.073	1.244	1.369	1.433	1.405	1.304
4	I C I C I Bank Ltd.	1.123	1.17	1.336	1.325	1.093	1.209
5	Indusind Bank Ltd.	1.151	1.03	1.011	1.09	1.168	1.09
6	Kotak Mahindra Bank Ltd.	1.028	1.268	1.099	1.16	1.208	1.152
7	Yes Bank Ltd.	1.064	1.082	1.025	1.212	1.053	1.087
	Average (year wise)	1.154	1.143	1.150	1.227	1.195	1.174

Computed using frontier 4.1

Table 7: SFA-cost Translog estimates -new private sector bank

Variables	Variables	OLS Coefficient	OLS t-value	Corrected OLS coefficient	ML Coefficient	ML t-value
beta0	Intercept	0	-0.003	-0.069	-0.001	-0.023
beta1	Y1	-11.41	-1.352	-11.406	-11.687	-12.53*
beta2	Y2	7.115	0.746	7.115	7.098	7.613*
beta3	P1	7.156	0.767	7.156	7.168	7.712*
beta4	P2	-7.803	-1.152	-7.803	-7.706	-8.833*
beta5	P3	-8.78	-0.937	-8.78	-9.233	-9.621*
beta6	Y1*Y1	3.533	0.465	3.533	3.535	4.963*
beta7	Y1*Y2	-1.302	-0.155	-1.302	-1.471	-1.707
beta8	Y2*Y2	-2.761	-0.446	-2.761	-2.538	-3.64*
beta9	P1*P1	6.333	0.587	6.333	6.339	9.307*
beta10	P1*P2	0.163	0.601	0.163	0.146	0.816
beta11	P1*P3	-14.79	-1.373	-14.788	-14.601	-16.95*
beta12	P2*P2	3.786	1.052	3.786	3.753	7.934*
beta13	P2*P3	-0.447	-0.679	-0.447	-0.431	-0.322***
beta14	P3*P3	6.577	0.911	6.577	6.486	9.834*
beta15	Y1*P1	-7.38	-0.837	-7.38	-7.434	-8.778*
beta16	Y1*P2	-0.556	-0.383	-0.556	-0.429	-0.663
beta17	Y1*P3	14.136	1.375	14.136	14.539	16.581*
beta18	Y2*P1	2.203	0.224	2.203	2.041	2.376
beta19	Y2*P2	0.596	0.409	0.596	0.462	0.693
beta20	Y2*P3	-2.739	-0.31	-2.739	-2.751	-3.113**
delta0				0	-0.371	-2.055
delta1				0	0.113	2.789**
Sigma-squared		0.018		0.013	0.01	4.216*
Gamma				0.57	1	29.032*
Log likelihood function		38.872			46.034	
LR test of the one-sided error					14.325	

Computed using frontier 4.1; * 1% significance level; ** 5 % significance level; *** 10% significance level

Banks, Number of Employees had improved by 231.50% for the study period.

The log-likelihood function for full stochastic model is calculated as e46.034 and the value for OLS function is 38.872, 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 14.325. This value is significantly higher than the critical value (2.706 at 5% level of significance, provided by Kodde and Palm (1986) for df equal to 1).

The sigma-square is 0.01 significant, indicating the correctness of the of the composite error term. The gamma value is 1.00 and significant at the 1% level. It is an indication that 100 % variation in output is attributed to bank specific technical inefficiency.

The variation in cost efficiency have decreased over time. It is represented by the delta values. The difference in cost inefficiency between the best practice and worst practice banks is significantly increased by 11.3 % by Information technology. Thus, some of new private sector bank cost in inefficiency reduced by 11.3%. The information technologies contribute to cost inefficiency.

Table 8: Analysis of variance (Bank-wise)

Source of variation	SS	Df	MS	F	F-crit
Between banks	0.174795	7	0.024971	1.760976	2.312741
Within banks	0.453763	32	0.01418		
Total	0.628558	39			

Computed using SPSS 16.0

Table 9: Analysis of variance (Year-wise)

Source of variation	SS	Df	MS	F	F-crit
Between the year	0.014777	4	0.003694	0.21066	2.6414
Within the year	0.613781	35	0.017537		
Total	0.628558	39			

Computed using frontier 4.1

Table 8, gives the results based on ANOVA test. As the calculated value is (1.760976) lesser than the

table value (2.312741), the null hypothesis (H_{07a}) is accepted. Thus, there is no significant difference among the Indian new private sector bank in their cost efficiency.

Table 9 gives the results based on ANOVA test. As the calculated value is (0.21066) lesser than the table value (2.6414), the null hypothesis (H_{07b}) is accepted. Thus, there is no significant difference in cost inefficiency among the Indian new private sector bank in year-wise.

RESULTS AND DISCUSSION

Old private sector bank: The results show that overall the banks are over 5.1% Cost inefficient i.e., 94.9% Cost efficient Joint significance of Deposit and Physical capital indicate Old private sector bank are increasing their deposit and reducing the rent expenses to attain the cost efficiency for the period 2009-2013.

Labour expenses are increased significantly which leads to cost inefficiency in Old private sector bank. Number of Employees had improved by 19.83% for the study period. Physical capital expenses are increased significantly which leads to cost inefficiency in Old private sector bank.

The variation in cost efficiency seems to have decreased over time, as represented by the delta values. The difference in cost inefficiency between the best practice and worst practice banks is significantly increased by 28% for the period by Information technology.

Thus, some of Old private sector bank cost inefficiency reduced by 28% for the study period by Information Technology (IT). The information technology contributes cost efficiency.

New private sector banks: The results show that overall the banks are over 17.4% Cost inefficient i.e., 82.6 % Cost efficient.

New private sector banks are effectively handling their loan portfolio for the period 2009-2013. Deposit indicates the Interest expenses are reduced significantly even though there is a increase in deposit. Deposit improved by 182.899% for the study period.

Physical capital indicates the rent expenses are decreased significantly which leads to cost efficiency in new private sector banks. Joint significance of Investments and Physical capital indicate new private sector bank are increasing their Investments and reducing the rent expenses to attain the cost efficiency.

Investments indicate the improper Investments are increased significantly which leads to cost inefficiency in New private sector bank. Labor are increased significantly which leads to cost inefficiency in New private sector bank. For new private sector Banks, Number of Employees had improved by 231.50% for the study period.

There is a significant difference among the Indian old private sector bank in their cost efficiency with bank wise and year wise.

There is no significant difference among the Indian new private sector bank in their cost efficiency with bank wise and year wise.

For old private sector bank cost inefficiency reduced by 28% for the study period by Information Technology (IT) and for new private sector banks cost inefficiency reduced by 11.3%. Thus the information technologies contribute to cost efficiency.

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