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ASSESSING THE IMPACT OF COMPUTERIZATION ON PRODUCTIVITY AND PROFITABILITY OF INDIAN BANKS

AN APPLICATION OF DATA ENVELOPMENT ANALYSIS

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INDIAN Indian banks are investing heavily in the technologies such as telebanking, mobile banking, net banking, automated teller machine (ATMs), credit cards, debit cards, smart cards, call centers, CRM, data warehousing etc. To convince the management, investors and other stakeholders for this heavy investment in technology, it is desirable to evaluate the impact of computerization on the performance of Indian banks in terms of their profitability and productivity. In this paper, after defining input and output parameters, Data Envelopment Analysis (DEA) is used to study the impact of computerization on Indian banks' profitability and productivity. Private sector banks, which took more IT initiative were found to be more efficient in productivity and profitability parameters than public sector banks.

Keywords: *Computerization, Data Envelopment Analysis, Productivity and Profitability of Indian Banks.*

Introduction

Liberalization and financial sector reforms during the last one decade have brought the issue of productivity and profitability of banks into the limelight. Profitability of banks has been under strain on account of declining net interest margin and increasing competition. The comfortable business of accepting deposits and lending at administered rates has been dented following deregulation of interest rates and increase in competition after the entry of private and foreign banks. In the changing context, banks with a high degree of cost effectiveness, increased efficiency and customer centric approach would survive. Use of modern risk management practices, exploring ways to increase non–fund based income, analysis and control over expenses and greater use of information technology have become imperative to protect their bottom-lines in the deregulated environment.

Information Technology (IT) innovations in the last few years have changed the landscape of banks in India. Today, IT seems to be the prime mover of all banking transactions. Electronic and Information Technology together are bringing a swift change in the way banks operate, especially offering better delivery channels and customers' friendly services. Anywhere banking, telebanking, mobile banking, net banking, automated teller machine(ATMs), credit cards, debit cards, smart cards, call centres, CRM, data warehousing have totally transformed the banking industry. Today almost all the major banks in India like ICICI Bank, UTI Bank, Citibank, Standard Chartered Bank, ABN Amro, SBI and PNB are offering online services to their customers. ATMs have emerged as the most favoured channel for offering banking services to the customers in the world. In India, currently, there are two types of customers – one who is a multi-channel user and the other who still relies on the branch as the main

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channel. The primary challenge for banks is to provide consistent service to customers irrespective of the kind of channel they use. The channels broadly cover the primary channels of branch (i.e. teller and ATM), phone (i.e. call centre, interactive voice response unit), and internet channel (i.e. personal computer, browser, wireless) banking. Banks in India have all set for transformed branches, enhanced telephone services, and internet banking functions. Even for PSBs, the ongoing and future investments are massive. The available data about the investment plans in PSBs in IT in the year 2003–04 indicates that all major PSBs have earmarked the hefty amount of Rs. 2200 crore (The Financial Express Oct. 17, 2003). The progress of IT usage in banks in India on different parameters is summarized below (Table 1):

Table 1: Information Technology and its Usage in Banks in India

Items / Year	Public sector Banks					Old Private sector Banks				
	96	97	98	99	00	96	97	98	99	00
Fully Computerized branches as % of total branches	3.14	5.26	7.84	10.31	13.79	8.38	12.01	16.60	23.78	30.74
ATMs as % of total branches	0.11	0.24	0.38	0.49	0.80	0.00	0.11	0.15	0.29	0.39
Computer Literate employees as % of total staff	7.92	10.64	14.02	20.01	21.51	11.62	16.14	21.37	28.63	34.03
IT specialists as % of total staff	0.19	0.24	0.33	0.39	0.47	0.52	0.55	0.81	1.20	1.50
IT expenditure as % of operating profits	3.97	4.17	5.10	5.53	6.60	4.23	4.01	2.52	3.91	5.13
IT investments as % of operatingprofits	4.72	5.34	6.32	8.02		5.91	4.01	3.92	6.99	
ALPM* branches as % of total branches	6.44	8.78	9.70	10.50	12.21	8.77	10.03	10.57	10.35	12.48

Table 1: Information Technology and its Usage in Banks in India (Contd..)

Items / Year	New Private sector Banks					Foreign sector Banks				
	96	97	98	99	00	96	97	98	99	00
Fully Computerized branches as % of total branches	100	100	100	100	100	100	100	100	100	100
ATMs as % of total branches	89.19	87.7	89.9	87.67	89.19	87.7	89.19	87.7	89.2	88
Computer Literate employees as % of total staff	100	100	100	100	100	100	100	100	100	100
IT specialists as % of total staff	4.95	4.5	5.0	4.52	4.95	4.52	4.95	4.5	4.9	4.5
IT expenditure as % of operating profits	6.75	5.9	6.8	5.89	6.75	5.89	6.75	5.9	6.8	5.9
IT investments as % of operatingprofits	41.84	21.4	41.8	21.35	41.84	21.35	41.84	21.4	41.8	21.4
ALPM* branches as % of total branches	N.A.	N.A.	N.A.	N.A.	N.A	N.A.	N.A.	N.A.	N.A.	N.A.

**** ALPM: Advance Ledger Posting Machine***

Source: RBI Bulletin, December, 2002.

The progress on the IT deployment in banks in India on various parameters viz. computerized branches, ATMs, computer literate employees, IT specialists and IT investment is shown in table 1.

From the table 1, it is clear that the performance of new private sector banks is unmatchable. The public sector banks are the worst in terms of these parameters, although their performance is picking up. Data Envelopment Analysis (DEA) is a non-parametric method used for evaluating the relative efficiency of similar units, referred to as decision making units(DMUs). Traditional approaches of efficiency measurements focus on averages and estimations of parameters and utilize only a single optimized regression equation assumed to be a appropriate for every DMU. In DEA, the performance measure of each DMU is optimized. DEA calculates the best possible performance for each DMU relative to all other observed measures.

This research attempts to analyze the impact of IT initiatives, which are taken more by private and foreign banks as compared to public sector banks(see table1) using DEA approach.

Review of Literature

Over the years several studies have been conducted both at the industry and firm level to examine the impact of IT on productivity and profitability. Some of them have drawn on statistical correlation between IT spending and performance measures such as profitability or stock's value for their analysis(Dos Santos et al; 1993). They found an insignificant correlation between IT spending and profitability measurers, implying thereby that IT spending is unproductive. Brynjolfsson and Hitt (1996), however, caution that these findings do not account for the economic theory of equilibrium which implies that increased IT spending does not imply increased profitability. More recent firm level studies, however, point a more positive picture of IT contributions towards productivity. These findings raise several questions about mis-measurement of output by not accounting for improved variety and quality and about whether IT benefits are seen at firm level or at the industry level. Such issues have been discussed in detail by Brynjolfsson (1993) and to a lesser extend by Brynjolfsson and Hitt (1996).

One illustration of the industry level studies is that of Morrison and Bernlt(1990), which found that in manufacturing industry 'estimated marginal benefits of investment in IT are less than the marginal cost, implying the problem of over investment. More specifically they found that for each dollar spent on IT, the marginal increase in output was only 80 cents. Similarly Loveman(1994) found insignificant contribution of IT expenditure to the output of manufacturing firms. Lichtenberg(1995), on the other hand, concludes that there are significant benefits from investment in IT to the firms. Using Cobb-Douglas production function, he found increasing returns on investment in computers. They further found that one information system(IS) employee is equivalent to six non-IS employees in terms of marginal productivity.

Brynjolfsson and Hitt (1996) in their study by using Cobb-Douglas production function have found that computerization aids to the firm's level output significantly. In fact they found that computer related capital investment contributes 81 percent to the marginal increase in output, where as non-IT capital contributes only 6% to the marginal output. They also show that IS labor is more than twice as productive as non- IS labor.

Most of such studies relating to the contribution of IT towards firm's level productivity have been restricted to the manufacturing industry, possibly owing both to a lack of data at the firm level in the service industry and perhaps, more significantly, in the difficulty of unambiguously identifying the "output" of a service industry. The latter problem is particularly persistent in the banking industry, which is the focus of this study.

The study by Parsons, Gotlieb, and Denny (1993), is one of the studies that deal with the impact of IT in banking productivity per se. They conclude from their estimation of data from five Canadian banks

using translog production function that, while there is a 17-23 percent increase in productivity with the use of computers, the returns are very modest compared to the levels of IT investments. The other study to examine the effect of IT investment on both productivity and profitability in the US retail banking sector is conducted by Prasad and Harker (1997). They conclude that additional investment in IT capital may have no real benefits and may be more of strategic necessity to stay within the competition. However, the results indicate that there are substantially high returns to increase in investment in IT labor. The other study conducted by Launardi, Becker and Macada (2003), found competition, products and services, and customers, the main strategic variables affecting the IT and there is no difference of opinion between IT executives and other functional executives, regarding their perception of the impact of IT on strategic variables. Another important study undertaken by offsite monitoring and surveillance division of department of Banking Supervision (2002) used financial indicators to derive indirect linkages by assuming computerization as one of the factor in the improvement in efficiency. They concluded that higher performance levels have been achieved without corresponding increase in the number of employees. Also, it has been possible for Public Sector Banks and Old Private Banks to improve their productivity and efficiency over a period of five years.

Choudhari and Tripathy (2004) applied DEA to measure the relative performance of public sector banks and conclude that the Corporation Bank is the efficient in all indicators i.e. profitability, financial management, growth, productivity, and liquidity, while Oriental Bank of Commerce is next most efficient. Kamakura and Ratchford(1996) evaluated multiple retail stores for their efficiency using DEA and translog cost function.Many other studies used DEA in a banking setting. Some incorporated computer terminals as input measurement(Oral and Yolalan 1990; Vassiloglon and Giokas 1990) or access time(Soterion and Zenios 1999; Zenios, et al. 1999).This study also uses DEA to analyze the impact of computerization on productivity and profitability of banks.

Data Envelopment Analysis and its Rationale for the Study

Charnes, Cooper and Rhodes (1978) first proposed DEA as an evaluation tool to measure and compare a DMU productivity. After that this tool was extensively used in banking and other areas to measure the DMU relative productivity. Examples include the maintenance activities of U.S. Air Force bases in different geographic locations, or police forces in England and Wales as well as performances of branch banks in Cyprus and Canada and the efficiency of universities in performing their education and research functions in U.S., England and France. These kinds of applications extend to evaluating the performances of cities, regions and countries with many different kinds of inputs and outputs that include "social" and "safety-net" expenditures as inputs and various "quality-of-life" dimensions as outputs.(Cooper et al., 2000). Data Envelopment Analysis is an approach of comparing the efficiency of organizational units such as bank branches, schools, hospitals and other similar instances, where there is a relatively homogenous set of units. The analysis will measure output(s) achieved from the input(s) provided and will compare the group of DMUs by their strength in turning input into output. At the end of analysis the DEA will be able to say, which units are (relatively) efficient and which are (relatively) inefficient.

The Data Envelopment Analysis is a method for mathematically comparing different decision-making units' (DMUs) productivity based on multiple inputs and outputs. The ratio of weighted inputs and outputs produce a single measure of productivity called relative efficiency. DMUs that have a ratio of 1 are referred to as efficient, given the required inputs and produced outputs. The units that have a ratio less then 1 are less-efficient relative to the more efficient unit(s). Because the weights for input and output variables of DMU are computed to maximize the ratio and then compare to similar ratios of best performing DMUs, the measured productivity is also referred to as relative efficiency.

Approaches of performance measurements

There are various parametric and non-parametric approaches to measure performances. Performance ratios are widely used in all sectors of business. The best known ratios are for financial and production

managers. The financial ratios regarding liquidity, capital adequacy, earnings and liability are widely used measures of organizational performance. However, they have one disadvantage. Each single ratio must be compared with some benchmark ratio one at a time. While the calculation of a set of financial ratios is relatively easy, the aggregation of those ratios can be quite complicated-involving experienced judgment. Financial ratios do provide information on the overall financial performance of an organization, but provide little information about the amount by which performance could be improved or the area where the effort should be focused in order to improve performance. On the other hand, DEA method not only finds the efficient DMUs but also tells how to make other inefficient DMUs efficient by varying in the input and output parameters by suggested amount.

The regression models are quantitatively robust, they lack the ability to include multiple inputs and outputs because regression models usually restrict the analyst to one dependent variable. Regression models also provide only an estimate of model success, while offering no feedback about improvement possibilities. Additionally, regression models impose a particular functional form on the data, producing a single function that represents a set of hypothetical "average" performers. DEA, on the other hand, produces an efficient frontier consisting of the set of most efficient performers, allowing a direct comparison to the best performers as opposed to average. The difference between regression and DEA is illustrated in Figure 1 (Donthu et al., 2005).

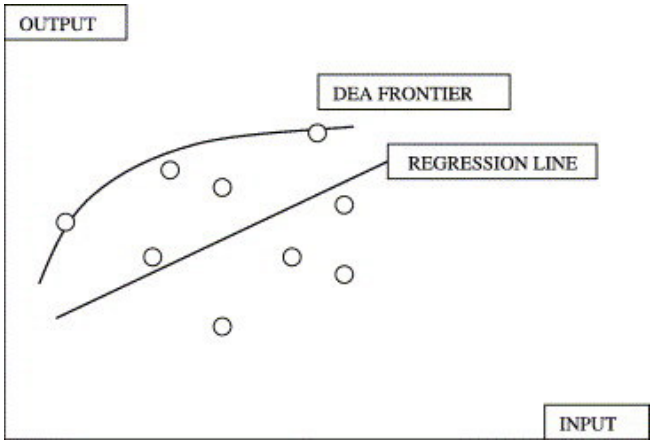

Fig. Regression versus DEA

While the regression produces an "average line across all DMUs, DEA produces an efficient frontier that encompasses the best performers. While DMUs above the regression line appear to be performing better then the average, they are not performing as well as the best performers or most productive DMUs on the efficient frontier.

DEA Model Selection

One of the basic choices in selecting a DEA model is whether to use an input-orientation or an output-orientation. The difference is subtle but important and can typically be best understood by considering whether a DMU emphasizes on reducing input while achieving the same level of output or emphasizes on producing more output given the same level of input.

DEA offers three possible orientations in efficiency analysis (Charnes et al. 1994):

(a) Input–Oriented models are models where DMUs are deemed to produce a given amount of output with the smallest possible amount of input.

(b) Output-Oriented models are models where DMUs are deemed to produce the highest possible amount of output with the given amount of input.

(c) Base-Oriented models are models where DMUs are deemed to produce the optimal mix of input and output.

Return to Scale

Return to scale refers to increasing or decreasing efficiency based on size. For example, a manufacturer can achieve certain economies of scale by producing thousand Integrated Circuit at a time rather than one at a time-it might be only 100 times as hard as producing one at a time. This is an example of Increasing Returns to Scale (IRS).

On the other hand, the manufacturer might find it more than trillion times difficult to produce a trillion Integrated Circuit at a time because of storage problems and limitations on the worldwide Silicon supply. This range of production illustrates Decreasing Returns to Scale (DRS). Combining the extreme two ranges would necessitate Variable Returns to Scale (VRS).

Constant Returns to Scale (CRS) means that the producers are able to linearly scale the inputs and outputs without increasing or decreasing efficiency. This is a significant assumption. The assumption of CRS may be valid over limited ranges but its use must be justified. As an aside, CRS efficiency scores will never be higher than that of VRS efficiency scores.

In a CRS model, the input-oriented efficiency score is exactly equal to the inverse of the output-oriented efficiency score. This is not necessarily true for inefficient DMUs in the case of other return to scale assumptions. The CRS version is more restrictive than the VRS and yields usually a fewer number of efficient units and also lower efficient score among all DMUs.

In DEA literature the CRS model is typically referred to as the CCR model after the originators of the seminal publication, Charnes, Cooper and Rhodes (1978).

CCR Model of DEA

DEA is a linear programming based technique for measuring relative performance of DMUs. CCR Model, which was initially proposed by a Charnes, Cooper and Rhodes, can be represented as a fractional linear programming problem:

$$E_o = \frac{u_1y_{1o} + u_2y_{2o} + \ldots\ldots + u_sy_{so}}{v_1x_{1o}+v_2x_{2o}+\ldots\ldots\ldots+v_mx_{mo}}$$

subject to

$$\frac{u_1y_{1j} + u_2y_{2j} + \ldots\ldots + u_sy_{sj}}{v_1x_{1j}+v_2x_{2j}+\ldots\ldots\ldots+v_mx_{mj}} \leq (j=1, \ldots,n)$$

$$v_1,v_2,\ldots\ldots\ldots,v_m \geq 0$$

$$u_1,u_2, \ldots\ldots\ldots,u_s \geq 0$$

where Eo= the efficiency of the o^{th} DMU,

Y_{so} = s^{th} output of o^{th} DMU,

U_s = weight of s^{th} output

X_{mo} = m^{th} input of the o^{th} DMU

V_m = weight of m^{th} input

Here the DMU_j to be evaluated on any trial be designed as DMU_o where o ranges over 1,2,…,n.

The constraints mean that the ratio of "virtual output" vs "virtual input" should not exceed 1 for every DMU. The above fractional program can be replaced by the following linear program:

$$\text{Maximize } Eo = u_1y_{1o} + v_2y_{2o} + \ldots + u_sy_{so}$$

$$\text{Subject to } v_1x_{1o} + v_2x_{2o} + \ldots + v_mx_{mo} = 1$$

$$U_1y_{1j} + u_sy_{sj} \leq v_1x_{1j} + v_2x_{2j} + \ldots + v_mx_{mj} \quad (j = 1,\ldots,n)$$

$$V_1, v_2, \ldots v_m \geq 0$$

$$u_1, u_2, \ldots u_m \geq 0$$

The DEA model is a fractional linear program but may be converted into linear form in a straight forward manner so that the methods of linear programming can be applied. The fractional program can be converted to linear program by normalizing either the numerator or the denominator of the fractional program objective function. The weighted sum of the inputs is constrained to be unity in the linear program. As the objective function is the weighted sum of outputs that has to be maximized, this formulation is referred to as the output maximization DEA program.

The key feature of above model is weights are treated as unknown. They can be obtained by solving the fractional programming problem to obtain values for the inputs weights (v_i) (i=1,…,m) and the output weights (u_r)(r=1,….,s) as variables. The value obtained of these weights will maximize the efficiency of the o^{th} target units.

The Present Study

From the study conducted by the Off-site monitoring and surveillance division of RBI, it is clear that IT initiatives taken by private and foreign banks are more than the public sector banks. The benefits of computerization in boosting productivity and profitability performance of banks is difficult to quantify in precise terms, since several other factors are also responsible for the outcomes. Thus, it is very difficult to pinpoint as to how much of this improvement in productivity and profitability is directly attributable to computerization. However, it is possible to drive indirect linkage by assuming computerization as one of the important factor for improvement in productivity and profitability.

The selection of indicators for study have been decided with the view of identifying the impact of computerization. Now to analyze the impact of computerization on the productivity and profitability of the banks, banks from private and public sectors were selected randomly. The input included in analysis of productivity indicators is *staff expenses* to *operating expenses*. This is the measure of resource usage. The availability of ATMs and internet banking and other computerization efforts should help the banks to generate high volume of business with low number of people. Corresponding outputs are *business per employee, total income per branch* and *operating profit per branch*. Similarly input parameter for profitability efficiency is *staff expenses to operating expenses* and corresponding outputs used are *net profit to deposits*, *operating profit to average working funds*, *return on assets* and *profit margins*.

The CCR output-oriented model (output maximization) was utilized to evaluate the data. If data pertaining to a particular DMU was not available, the bank was excluded from the analysis for the particular indicator/year. The data for analysis have been used from PROWESS 2.5, a corporate database developed by Center for Monitoring Indian Economy (CMIE) and from the websites of the selected banks. The data are based on banks' performance in the year 2003-04 and 2004-05. DEA-Solver software was used to solve linear programming model.

Results and Discussions

The DEA results on productivity and profitability parameters (affected by computerization) are summarized in table 2 and table 3 respectively. The results from CCR model give the overall efficiency of banks. The DMU(s) score the rating 1 considered to be efficient and others considered to be relatively inefficient.

Table 2: DEA efficiency score of banks with reference units for productivity indicators affected by computerization

		2003-04			2004-05		
No.	**DMU**	**Scores**	**Rank Units**	**Reference**	**Scores**	**Rank Units**	**Reference**
1	Allahabad Bank	0.0625	21	13	0.111462	16	13
2	Andhra Bank	0.1	14	13	0.101466	20	13
3	Bank Of Baroda	.0783	18	13	0.104377	17	13
4	Bank Of India	.0793	17	13	0.126482	15	13
5	Bank Of Maharashtra	0.108333	11	13	0.103147	19	13
6	Bank Of Rajasthan Ltd.	0.05	23	13	0.0568	25	13
7	Bharat Overseas Bank Ltd.	0.107143	12	13	0.182684	9	13
8	Canara Bank	0.1	14	13	0.132955	14	13
9	City Union Bank Ltd.	0.245455	5	13	0.211688	8	13
10	Corporation Bank	0.158824	7	13	0.248864	6	13
11	Federal Bank Ltd.	0.132353	9	13	0.17512	11	13
12	H D F C Bank Ltd.	0.428713	3	13	0.523377	3	13
13	I C I C I Bank	1	1	13	1	1	13
14	I N G Vysya Bank Ltd.	0.105	13	13	0.179545	10	13
15	Indian Bank	.0273	26	13	N.A.	N.A.	N.A
16	Indian Overseas Bank	.0783	18	13	0.0873	21	13
17	Jammu & Kashmir Bank Ltd.	0.18	6	13	0.282468	5	13
18	Lord Krishna Bank Ltd.	0.122376	10	13	0.231818	7	13
19	Oriental Bank Of Commerce	0.3	4	13	0.36014	4	13
20	Punjab & Sind Bank	.0254	27	13	N.A.	N.A.	N.A.
21	Punjab National Bank	0.0625	21	13	0.0741	23	13
22	South Indian Bank Ltd.	0.134211	8	13	0.168421	12	13
23	State Bank Of India	0.06875	20	13	0.0736	24	13
24	Syndicate Bank	.0432	25	13	0.0848	22	13
25	U T I Bank Ltd.	0.7875	2	13	0.625874	2	13
26	Uco Bank	.0493	24	13	0.104221	18	13
27	Vijaya Bank	.0886	16	13	0.149761	13	13

Table 3: DEA efficiency score of banks with reference units for profitability indicators affected by computerization

		2003-04			2004-05		
No.	**DMU**	**Scores**	**Rank Units**	**Reference**	**Scores**	**Rank Units**	**Reference**
1	Allahabad Bank	0.354098	15	9,13,25	0.421221	9	13
2	Andhra Bank	0.499546	10	9,13,19	0.416691	10	13
3	Bank Of Baroda	0.320406	18	9,13,25	0.332994	14	13
4	Bank Of India	0.338368	17	19,25	0.258476	17	13
5	Bank Of Maharashtra	0.366375	14	13,25	0.241355	19	13
6	Bank Of Rajasthan Ltd.	0.250643	23	19,25	0.113067	22	13
7	Bharat Overseas Bank Ltd.	0.410459	13	13,25	0.30581	16	13
8	Canara Bank	0.538972	8	13,19	0.379205	11	13
9	City Union Bank Ltd.	1	1	9	0.61599	5	13
10	Corporation Bank	0.653703	7	13,25	0.844037	2	13
11	Federal Bank Ltd.	0.451185	12	19,25	N.A.	N.A.	N.A.
12	H D F C Bank Ltd.	0.810204	6	13,25	0.671035	4	13
13	I C I C I Bank	1	1	13	1	1	13
14	I N G Vysya Bank Ltd.	0.288021	21	19,25	N.A.	N.A.	N.A.
15	Indian Bank	0.162255	26	9,13,25	N.A.	N.A.	N.A.
16	Indian Overseas Bank	0.308464	20	9,19,25	0.344692	13	13
17	Jammu & Kashmir Bank Ltd.	0.845858	5	13,25	0.458716	8	13
18	Lord Krishna Bank Ltd.	0.456448	11	9,13,25	N.A.	N.A.	N.A.
19	Oriental Bank Of Commerce	1	1	19	0.705716	3	13
20	Punjab & Sind Bank	N.A.			N.A.	N.A.	N.A
21	Punjab National Bank	0.316696	19	19,25	0.242849	18	13
22	South Indian Bank Ltd.	0.340643	16	19,25	0.351521	12	13
23	State Bank Of India	0.261719	22	19,25	0.319266	15	13
24	Syndicate Bank	0.200176	25	13,25	0.229969	20	13
25	U T I Bank Ltd.	1	1	25	0.575865	7	13
26	Uco Bank	0.222165	24	9,13,25	0.226737	21	13
27	Vijaya Bank	0.501365	9	9,19	0.581362	6	13

For productivity indicators in the year 2003-04, ICICI bank scored the efficiency rating 1 and hence form the efficient frontier and act as reference unit for rest all 26 banks. UTI bank, HDFC bank and Oriental Bank of Commerce ranked 2, 3 and 4 respectively with the efficiency scores of 0.78,0.43 and 0.30. Except Oriental Bank of Commerce and Corporation Bank all top ranks are scored by private banks. In the year 2004-05 again ICICI Bank remained most efficient with the score 1 and hence act as reference unit for others. Again top ranks are obtained by private sector banks. Only two of the public

sector banks ,Oriental Bank of Commerce and Corporation Bank were in top 10. It can further seen that efficiency scores of public sector banks are quite lower than that of private sector banks.

Looking at the profitability efficiency scores of the year 2003-04, City Union Bank Ltd, ICICI Bank, Oriental Bank of Commerce and UTI Bank were found to be efficient and form efficient frontier. While Indian Bank and Syndicate Bank are found to be most inefficient with the scores of 0.16 and 0.20 respectively. Here also private sector banks perform better than the public sector banks. Looking at the year 2004-05, again ICICI Bank was found to be efficient as compared to rest of the banks. However, this time second and third ranks are secured by Corporation Bank and Oriental Bank with efficiency scores of 0.84 and 0.70 respectively. But then next five consecutive ranks are scored by private sector banks.

Conclusion

In the present study researchers have tried to correlate, the computerization in banks to their productivity and profitability. Results show that ICICI Bank is found to be efficient in all indicators. ICICI Bank has been the leader in IT introduction and adoption. ICICI Bank initiated internet banking services in the year 1997.This was followed by HDFC Bank, Indusind Bank, Federal Bank, Citibank and ABN AMRO. Nearly 70% of ICICI Bank transactions take place electronically, resulting in lower cost of transactions, high productivity and better profitability. Table 1 clearly indicates that private banks are the early adopter of technology and took more IT initiative than public sector banks. The input and output parameters, which are clearly affected by computerization in the banks were considered for productivity and profitability analysis. The output of DEA, indicates that private banks are much better than public banks in productivity and profitability indicators. Hence, of the many factors which could lead to improved performance of banks, increased IT investments is one of the vital contributing factors for enhanced performance.

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