Impact Of IT On Indian Commercial Banking Industry: DEA Analysis

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ABSTRACT

In recent time, Indian banking industry has been consistently working towards the development of technological changes and its usage in the banking operations for the improvement of their efficiency. To get the benefits of enhanced technologies, Indian banks are continuously encouraging the investment in information technology (IT), i.e. ATMs, e-banking or net-banking, mobile and tele-banking, CRM, computerisation in the banks, increasing use of plastic money, establishment of call centers, etc. RBI has also adopted IT in endorsing the payment system's functionality and modernization on an ongoing basis by the development of Electronic Clearing Services (ECS), Electronic Funds Transfer (EFT), Indian Financial Network (INFINET), a Real-Time Gross Settlement (RTGS) System, Centralized Funds Management System (CFMS), Negotiated Dealing System (NDS), Electronic Payment Systems with the 'Vision Document', the Structured Financial Messaging System (SFMS) and India Card – a domestic card initiative, implemented recently (2011). Therefore, Indian banking environment has become more compatible as compare to the standards of international financial system, by the positive impact of all these efforts. This study makes an attempt to map the impact of IT on banking sector for scheduled commercial banks operating in India including public, private and foreign sector banks in India. The study uses a non-parametric linear programming based technique. The results convey that all SCBs have shown a significant and improving trend in their performance due to the adoption of IT. This adoption is required mandatory to take the country into the 21st century.

KEYWORDS

DEA Model	Information Technology (IT)
Indian Banking Environment	Information and Communication Technology (ICT)

Preamble

Empirical Article

Indian banking industry has witnessed a remarkable development in the Informational Technology (IT) in last few years. Banking transactions are become easier and customer friendly due to the technological improvements. To play a supportive and key role, banks are providing with lots of services which are the combination of electronics and information technology, like, *Automatic Teller Machines (ATMs*, *plastic money* i.e. credit card, debit card and smart cards, *phone banking, e-banking* which is called by *net-banking*, etc. ATMs have emerged as the most favoured channel for offering banking services to the customers in the world (Mittal & Dhingra, 2007). RBI has also adopted IT in endorsing the payment system's functionality and modernization on an ongoing basis to improve the efficiency of banking sector. There is a noticeable improvement in the performance of financial institutions and the service sector by incorporating IT into their functionality. It shows an increasing share, enhanced competitiveness at the global surface because of adopting IT culture (Vittaldas Leeladhar). The advancements in information and telecommunication technologies (IT) since past 25 years clearly indicate a positive impact on banking and financial institutions (Rishi & Saxena, 2004).

Before the technological innovation, the functioning of all banks was manual for all the services including data handling, maintaining and processing the accounts, receiving the customers and fulfillment their needs etc. Customers had to pay their time, patience in banks to do their transactions completely. They had to face the multiple occurrences of unnecessary requirements within limited time period and to suffer by the lack of proper information to complete their financial desires. Attendants were limited compared to the customers; hence, were not capable of attending them efficiently and effectively within the given time framework. As a result of this growing dissatisfaction amongst the customers there was an imperative need to automate this sector so as to remove all these problems. In 1980's, the developments in IT with the advancement in personal computer (pc) and emerging networking made the transactions automatic by computerisation in the banks. Now, customers could use error free services due to development of information and communication technology (ICT). With this automation customer retention ratio went up as customers were very

satisfied with the modernization of the set up. The ICT, structural and functional changes were introduced in mode of banking transactions to electronic channels not only in urban areas but also in rural and NCR. This changed their strategic behaviour and enhanced their scale of operations. Indian Banking Sector witnessed new opportunities and challenges as there was a major drift in the present paradigm .IT improvements are significantly useful to reduce the cost and improve the efficiency of the banks. Technological efficiency can result in lower transaction costs and increased revenues for banks (Rishi and Saxena, 2004). Transactions through technology channels cost much less to the banks than the customers reaching the bank and doing the transaction. Relative Cost of banking transactions using various channels of IT are shown in Table1.

Table 1: Relative cost of banking transaction through different modes

Channel	Cost per transaction (Rs.)
Physical Branch	100
Postal	40
Telephone	18
ATMs	18
Internet	12

*Source: Bank of International Settlements

It is evident that information technology has brought key changes in the banking operations. Foreign and Private foreign sector banks were the leaders in adopting the new the technology to align their business processes and were successful in creating the synergies between the two. In case of public sector banks which had already had the massive physical infrastructure and to make these banks IT enabled Business Process Re-engineering (BPR) was required. Technology deployment is slow in these banks because of this reason. The main focus of the banks till now was on the deploying the technology. The main challenge now onwards for all the banks will be to make the customers use of the technology and reduce down the transactions cost. This study focuses on the technological challenges that banks needs to address, failing in which, they are likely to loose the market share in the times to come. Being focused on the aspect of IT, there is a requirement to analyse the impact of IT and other technological changes on the efficiency of Indian

commercial banks. This study will use DEA approach with two CCR & BCC input-oriented models i.e. minimization of inputs with the constant level of outputs and output-oriented model i.e. maximization of output with a constant level of input, to examine the impact. DEA approach is a non-parametric linear approach which is more useful in designing micro-level policies in the Indian banking industry. The analysis is based on the data of all SCBs of India for recent time period of five years from 2005-06 to 2009-10.

The evidence refers improved discrete efficiency level in all the groups but the leader is FBs as compare to PrSBs and PSBs respectively operating in India over the study concerned (2006-2010). The major objective of the study is to evaluate the improvement in overall as well as group-wise performance of all the scheduled commercial banks operating in India by measuring and comparing the efficiency scores of each group respectively. The results clearly exhibit a significant improvement in efficiency after the adoption of IT in Indian banking industry but also witnessed an increment in the scores of individual bank-group also. The analysis recommends that such increment would be driven due to *the technological improvement*, which spreads the range of production possibilities, with the financial innovation and emerging new strategies pursued by banks suited to their performance (Mohan 2005).

The paper is classified into following six sections as *Section 1:* presents a brief Introduction about IT introduction and its impact, *Section 2:* gives extensive Review of Literature. *Section 3:* conveys about the Conceptual Framework and Research Objectives, *Section 4:* gives elaboration on Data Collection and Methodology. *Section 5:* entails the Interpretation of Empirical Results and *Section 6:* exhibits the Conclusions of the study.

REVIEW OF LITERATURE

Negative relationship in profitability and introduction of IT

Many research studies have been done on the topic of IT investment and its impact on productivity and profitability of banks. Some studies have used *correlation* to find the impact of IT expenditure on the performance (Dos Santos et al. 1993). The analysis exhibits that IT spending is unproductive due to an insignificant correlation between IT spending and profitability measurers. These findings do not account for the economic theory of equilibrium that increment in IT spending doesn't imply improved profitability of banks (Brynjolfsson & Hitt 1996). They used *Cobb-Douglas production function* to assess the investment on computerisation at firm level. The research observed 81% increases in output due to computer related capital investment whereas only 6% increment in marginal output due to non-IT capital. A study is prepared by Morrison and Bernlt (1990) on manufacturing industry at industry level. The study observed that because of over investment in IT, estimated *marginal profits are less than the marginal cost and the increase in output* is only 80 cents for one dollar spends on IT. Another researcher also found the same insignificant contribution of IT expenditure to the output (Loveman, 1994). Similarly, Prasad & Harker (1997) conducted a study on US retail banking sector to assess the effect of IT. They also get the same conclusion as no real benefits of additional investment in IT within the competition.

Positive relationship in profitability and introduction of IT

In contradiction of above, following studies conclude that there are considerable increase in profitability from the enhanced investment in IT and IT innovations. Lichtenberg (1995), used the same Cobb-Douglas production function like Brynjolfsson & Hitt (1996), but the results are different. Lichtenberg (1995) exhibited that investment in computers is resulted as increased returns with the high marginal productivity. Basle Committee (1998) and Healy & Palepu (2001) are also agree in this statement. They suggest that the use of technology can improve/enhance systems for administrative control such as enabling better management of risk, which if disclosed in regulatory reports to supervisors and in annual reports to investors, can improve bank transparency and enable the banks to reduce their cost of capital. Hence, technology can be the key to differentiation, competitive edge, and institutional survival. The first wave of technology adoption was literally a move to computerize operations by PSBs to increase efficiency in retail banking operations. 3 Banks rapidly installed Automatic Ledger Posting Machines (ALPMs) and mini computers, and began an aggressive program of training programmers and data entry terminal

operators. The Rangarajan Committee (1989) provided further impetus to technology adoption by recommending full computerisation of both front and back office operations of large branches. Thus, the thrust of technology in its early phases was on branch automation, i.e., total automation of a bank with its own data base.

Innovations in information technology and development in IT sector has been enforced the convention of IT elements in maximum branch of banks. Public sector banks were late adopter of new technology as compare to private and foreign banks (Rishi & Saxena, 2004). Some studies present the impact of IT on one bank-group. Well-capitalized new banks have improved their services, management, and prudential supervisory capacity and as a result the efficiency of banks (Walter & Gray 1983; Gelb & Sagari 1990). The entry of foreign banks tends to lower interest margins, profitability, and the overall expenses of domestic banks (Claessens et. al. 2000; Levine 1996). Clarke et al. (2000), found the impact of foreign entry on domestic banking sector of Argentina. Some are based on PSBs only (Mittal & Dhingra, 2007). They measured impact of IT on profitability and productivity of PSBs. On the aspect of IT, the recent study is completed by Debaprosarma Nandy (2010). He analysed the development of IT (information technology) in Indian banks. The result presented an improved trend among IT and the performance of Indian banks.

In the presence of these studies, we can say that there are most of the studies focused at firm level or have a single aspect of IT i.e. computer (Parsons, Gotieb & Denny, 1993). The study used translog production function for five Canadian banks. The conclusion showed a 17-23% increase in productivity by using computers, the returns were very modest compared to the levels of IT investments. Another study, which has key importance in this regard, is undertaken by offsite monitoring and surveillance division of department of Banking Supervision (2002). This study used computerization (financial indicator) as one of the factor in improvement of the efficiency. The result exhibited the fact that superior performance can have without rising in the number of staff and also possible to improve their productivity and efficiency over a period of time. Lunardi, Becker & Macada (2003), found high competition as variable affecting

IT. As the time changed, it can be positive for the performance of banks, if banks will accept the competition in this new electronic era with managed strategies.

Many studies used DEA model to evaluate the efficiency of banking sector. Das et al., (2000) used DEA approach for all the three types of ownership—public, private and foreign. Kamakura & Ratchford, (1996) used DEA with translog cost function to measure efficiency of multiple retail stores. By using DEA, there are different views for input measurement. Some have taken computer as input measure (Oral and Yolalan, 1990; Vassiloglon & Giokas, 1990) whereas some others choose time (Zenios et al., 1999). Choudhari & Tripathy, (2004) used DEA for many parameters to assess the relative performance of PSBs .The study had following parameters, profitability, financial management, growth, productivity, and liquidity. Another user of this approach were Mukherjee *et al.* 2002; Kumar & Verma 2003; Sathye 2003; Gunjan M.Sanjeev; 2006; Gupta et al., 2008; Rezvanian *et al.*, 2008; Awdeh & Moussawi, 2009; Sunil & Rachita, 2010 etc. Some studies used different approach like stochastic frontier approach or regression model. Shirai (2001), used least square regression model to assess the governance of Indian banking system. Shanmugam & Das, (2004), used stochastic frontier approach to measure efficiency of banks groups. Sensarma, (2005 & 2008) used the same to analyse the performance of Indian banks.

After the extensive review of literature to observe the impact of IT on efficiency of Indian Banks, it is evident that there is no one comprehensive study available which throw light on all SCBs as well as individual bank groups, also the parameters the earlier studies have taken are also not exhaustive and complete. Present Paper is an attempt in this direction and will try to bridge the gap, taking the major parameters which could impact the efficiency and profitability of commercial banks and will also analyse the impact of IT on all SCBs as well as individual bank groups.

CONCEPTUAL FRAMEWORK

Technology Trends in Indian Banking Sector

Information and Communication Technology (ICT) has changed the working of banks and other financial institutions world wide. The major breakthrough started with use of *Advanced Ledger Posting Machines (ALPM)* in 1980s. The massive automation at branch level reduced errors in calculations and transactions and resulted in Customers getting error free service and was supplied with printed account statements. In late 1980s banks *total bank automation (TBA)* which means total automation of a particular branch with its own database, was introduced both the front-end and back-end operations within the same branch. In the sequence of mechanization steps initiated by the Indian banking sector Mechanized cheque processing systems have been established which used the *Magnetic Ink Character Recognition (MICR) technology.* After the financial sector reforms i.e. entry of new private sector banks and with the introduction of internet, banks opted for single centralized databases instead of having multiple databases for all their branches which resulted in low cost vis-a vis Decentralized networks. After the entry of private and foreign banks in 1996, public sector banks (PSBs) under the pressure of competition, have adopted several initiatives and technology is one of them. Some of the proactive PSBs have been striving hard to make their structures flexible enough to accommodate technological changes. Technology has put pressure on PSBs to restrict the branch network and employ a better skilled workforce. Technological revolution has strongly impacted strategic business considerations for Indian banks by cutting down costs of delivery and transaction massively. In India, presently there is clearly a digital divide – one who is multi-channel user and other who still relies on the branch as main channel. The challenge for the banks is to keep the customers happy irrespective of the kind of channel they use. New private sector banks and foreign banks employed ATMs, phone banking and internet banking from the day one. With no choice in the hand, public sector banks followed the suite; their ongoing and future investments are massive in the technology. Total expenditure incurred on computerization and development of communication networks by PSBs as on March 31, 2005 was 9487.37 crore (RBI reports 2005-06). On going status of computerization and expenses in PSBs is summarized in Table 2.

Table 2: Computerisation in Public Sector Banks

Years	Branches Fully Computerized	% of Partial Computerized	Expense Incurred
2005-06	77.4	18.2	10676
2006-07	85.6	12.4	12826
2007-08	94.6	5.4	15016
2008-09	95.7	4.3	17897
2009-10	97.8	2.2	22052
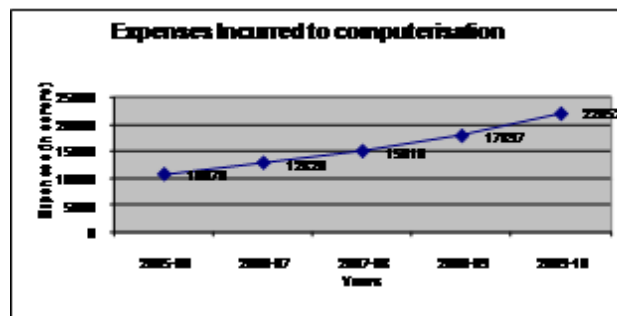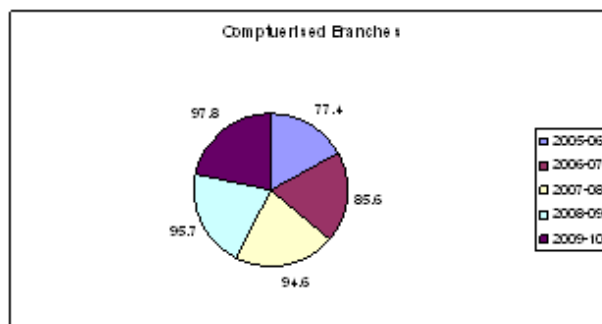
Introduction of IT shifted the whole paradigm in the working of banks where banks can create their own web pages, and customers of the banks can access these web pages through the web browsers by sitting at their homes. This kicked off online banking way back in 1996, while usage increased only after 1999 due to lower ISP online charges, increased PC penetration and technology stabilization. Customers enjoyed anytime anywhere banking as a consequent of Internet and could get their account information, bills could be paid online through the electronic bill payment service, online requests i.e. stop payment

of cheque , cheque book replenishment, demand draft, opening of fixed deposit account (Shroff, 2004) etc. could also be made.

The other significant developments include the evolution of the *ATM* channel, debit cards, mobile banking, and tele-banking through which the banking facilities are available to customers on a 24/7 basis across the world. Establishment of the *INFINET* in 1999 resulted in introduction of *Real Time Gross Settlement (RTGS) system* Internet has thus ushered the concept of any time and any where banking. It resulted in compliance with the core principles for systemically important payment systems of the Bank of International settlements (BIS), and has also provided the way for risk free, credit push-based fund transfers settled on a real time basis (Institute for Development and Research in Banking Technology, IDRBT, 2010). RTGS is available today across more than 23,700 branches of banks spanning more than 500 centers in the country for inter-bank funds settlement (Reddy, 2006).

Another paradigm shift is *Data warehousing* which is very vital in providing strategic information. Strategic information is required by the management information for continued health and survival of the bank. This information is not required for running the day-to-day operations of the business but for taking key and strategic decisions like where to open a new branch, which product lines to expand and which market is to strengthen. Data warehousing is the complete solution for providing *strategic information* not only this it makes available total view of the bank, makes the bank's current and historical information easily available for decision making, makes decision-support transactions possible without hindering operational systems (Paulraj, 2001). The story doesn't end here by automating the setup another challenge before bank is data mining i.e. discovering knowledge from the data warehouse. It is all about *knowledge discovery process* that reveals the patterns and trends in the data and helps in predicting future by the user also. *Data mining* can answer the query i.e. which customers are likely to be bad credit risks? Which branch will perform the best for coming two years? Which customers offer the best profit potential? Which customers are likely to switch to competition next year? Many banks have started paying greater attention to retain customers and wining new ones because of enhanced competition. Customer focus has become the catchphrase and need have today and is taken to be a winning strategy and have adopted *customer*

relationship management (CRM) systems to achieve the same. Banks are using Data mining also to provide vital information about the customer for better relationship management. Banks are setting *Knowledge Management System (KMS)* using ICT as they are lifeblood for banks in mitigating and managing risks. A good KMS must store all the knowledge in a knowledge repository, sometimes called a knowledge warehouse. It is a systematic process for capturing, integrating, organizing, and communicating knowledge accumulated by the banks which makes them more productive and efficient. As a part of the KMS banks have set up their own intranets and extranets, which are boon to both employees and customers, spread over wide geographic locations.

The year 2006-07 witnessed the commencement of consolidation of IT based efforts by the financial sector in general and by the commercial banks in particular. The major developments during the year included the setting up of the data centers, migration towards centralized systems and large scale implementation of core banking systems across bank branches. To enable banks to plan their IT road maps and ensure best results, the *Reserve Bank had published the Financial Sector (FST) Vision in 2005*. This document was reviewed in the context of IT developments and the draft document for the medium-term has been placed for public comments before it is finalized. The Mission Statement as 'IT for Efficiency and Excellence' and the corporate objective of 'enabling financial sector to leverage on IT for better customer service, improved housekeeping and overall systemic efficiency' continue to be the guiding principles of the FST Vision. Multi-application smart cards, which are heralding a new vista in banking, have made their presence felt as part of initiatives aimed at financial inclusion in parts of the North-East and the Southern regions. A smart card is a card which is similar to a credit/debit ATM card. The distinguishing feature lines in the presence of a chip in the card which can store information. Unlike in the case of magnetic-stripe based cards, the stored information in the chip could either be permanent in nature, or may be subject to change. For instance, the passwords can be changed at any frequency by the cardholder. Because of its additional feature, smart cards find usage not only for financial transaction processing but in a number of other areas as well. One of the greatest advantages of the smart card technology is its ability to consolidate multiple applications in a single, dynamic card. These cards

simplify life for end-users, often replacing up to three other cards for payment and other transactions. Thus, there can be a single card which can function as an identity card, as a driving licence, as a health card and also for other funds related purposes. Because these cards deliver such highly personalized applications, their perceived value among end-users is much higher and helps to build stronger than average customer loyalty. With Indian banking having embraced IT in a large way, the potential for usage of multi-application smart cards is high. Smart-card-based electronic purse systems, in which value is stored on the card chip and not in an externally recorded account so that machines accepting the card need no network connectivity.

Indian banking sector is left with no choice but to invest large funds to achieve this, considering the benefits. There are some empirical studies done which conform to this for e.g. in a survey conducted by McKinsey Consultancy (2002), it has been observed that there exists a large productivity gap between Indian banks and the US banks. This gap is found to be, to the extent of 90% in public sector banks, 68% in private sector banks including foreign banks. This study suggests that the banks should make more investment in information technology. However, for any further investment it becomes imperative to assess the impact of existing investment in terms of gains in banks' profitability and efficiency. Here study of all SCBs becomes all the more relevant as their ongoing and future investments are massive in technology. Although many studies have been conducted to investigate this effect, the results are not conclusive in supporting a systematic effect due to shortcomings in these studies. These shortcomings include; measurement errors, lags between investment and benefits, redistribution of profits and mismanagement of IT resources. The present study attempts to find the impact of information technology investments on the profitability and efficiency of all SCBs using Data Envelopment Analysis (DEA).

RESEARCH OBJECTIVES

Indian banking sector had to face many challenges as regards IT incorporation in the culture, like significant supply shocks of IT, user friendly technology and expansion of branches accordingly, reduction in cost, fully computerized system and risk bearing capability due to the enhanced technology etc. Indian banking industry is required to

acceleration growth, reduce the rate of inflation and maintain the financial stability (Mohan, 2005). To fulfill these requirements, the present status of Indian banking industry, importance of IT and the significant changes in performance of banks due to IT has to be properly vouched.

The *objectives* of this paper are as follows

- To asses the efficiency and profitability of Indian commercial banks.
- To analysis the role of Information Technology and its relevancy in Indian banks in the recent era.
- To measure the performance of the each bank group towards the elements of IT.

Following are the testable hypothesis:

Hypothesis 1: There is increase in profitability of Indian Commercial Banks in the study period (2005-06 to 2009-10).

Hypothesis 2: There is an increase in efficiency in the SCBs after the advent of IT.

Hypothesis 3: IT influx has resulted in higher efficiency level of each bank group.

METHODOLOGY

Data Collection

The study has measured the efficiency level of all the scheduled commercial banks (SCBs) operating in India during the study period of five years (2006-2010). In the year 2009-10, there are 28 Public banks, 22 Private banks and 27 Foreign banks under the heading of SCBs of India (RBI reports and publications, 2010). Therefore, the study has the data of 86 banks (some were absent from the study) for the study period. Data for few banks could not be included either they were closed down or merged with some other bank during the study period. The focus of the paper is to evaluate the efficiency scores and relative productivity as regards IT related factors using DEA analysis. There are two important aspects of DEA, following which it is preferable to study the population of banks. Firstly, it is *sample specific*, thus implying that results obtained for the sample cannot be generalized for the entire population. Secondly, it gives the *relative* efficiency scores and not the *absolute* efficiency scores. This means that the best performing DMU out of the

group will be shown as 100 per cent efficient. The rest of the DMUs will be benchmarked against this one. In case of DEA, the sample size should be generally larger than the product of the number of inputs and outputs (Dyson *et al.* 1998). Thus in this study, the sample size of 86 is sufficiently large to take care of the constraints imposed by the requirement of the DEA model. The data used in this study is financial information available in the Annual reports of the banks and RBI publications.

Data Envelopment Analysis

Charnes, Cooper & Rhodes (1978) first proposed DEA as an evaluation tool to measure and compare 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 application extend to evaluating the performance of cities, regions and countries with many different kinds of inputs and outputs that include "social" and "safety-net" expenditure 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 produces 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 performance. 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 analysis 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 (Donthu et al., 2005).
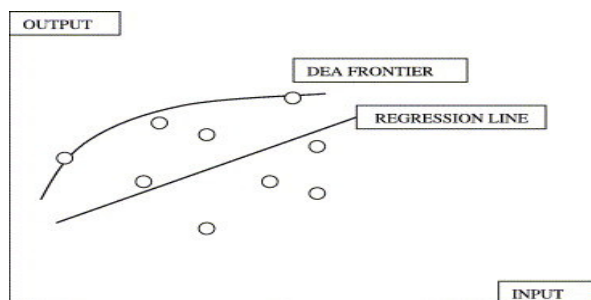
Fig 3: Regression versus DEA

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

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 Circuits 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

Circuits 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 Return 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. But, 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, by Charnes, Cooper and Rhodes (1978).

THE CCR MODEL OF DEA APPROACH

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

$$v_1,v_2,\ldots\ldots,v_m \geq 0 \quad \text{and} \quad u_1,u_2,\ldots\ldots,u_s \geq 0$$

where, E_o= the efficiency of the oth DMU,

$Y_{so} = $ s[th] output of oth DMU,

$U_s = $ weight of sth output

$X_{mo} = $ m[th] input of the oth DMU

$V_m = $ weight of mth 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 meant 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:

$$\text{Maximize,} \quad E_o = u_1 y_{1o} + v_2 y_{2o} + \ldots + u_s y_{so}$$

$$\text{Subject to,} \quad v_1 x_{1o} + v_2 x_{2o} + \ldots + v_m x_{mo} = 1$$

$$U_1 y_{1i} + u_s y_{si} \leq v_1 x_{1i} + v_2 x_{2i} + \ldots + v_m x_{mj} \ (j = 1, \ldots, n)$$

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

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

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 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 input weights (v_i) $(i=1,\ldots,m)$ and the output weights $(u_r)(r=1,\ldots,s)$ as variables. The value obtained of these weights will maximize the efficiency of the oth target units.

The BCC Model of DEA Approach

The output-oriented BCC model can be written as

$$\text{Max} \quad \eta B$$

$$\text{Subject to} \quad X\lambda \leq x_o$$

$$\eta B y_o - Y\lambda \leq 0$$

$$e\lambda = 1$$

$$\lambda \geq 0$$

This is the envelopment form of the output-oriented BCC model.

EMPIRICAL RESULTS

Hypothesis 1: There is increase in profitability of Indian Commercial Banks in the study period (2005-06 to 2009-10).

The relation of IT Investments and Indian commercial banking sector is significant. The paper is used following profitability indicators to measure the relationship, Net Profit (NP), Business Per Employee (BPE) and Profit Per Employee (PPE). All these factors are showing in following table 3 with clear picture through related figures.

All the banks are showing an increasing trend in NP during the study period see (Table 3.1). Each banks-group has an upward trail with satisfying growth due to innovation of IT; overall all SCBs have showed high NP. These results are consistent with findings of another study considering a temporal trend carried out by Bhattacharyya *et al.* (1997) who reported that the overall average performance increased after 1987 for the study period 1986-91.

Table 3: Profitability Indicators for Indian Scheduled Commercial Banks

Table 3.1: Net Profit (in lakh Rs.) as 1st Parameter

Years/Groups	PSBs	PrSBs	FBs	SCBs
2005-06	16539	4905	3096	24593
2006-07	20152	6485	4585	31202
2007-08	26592	9522	6612	42726
2008-09	34394	10868	7510	52772
2009-10	37428	11435	8214	57077
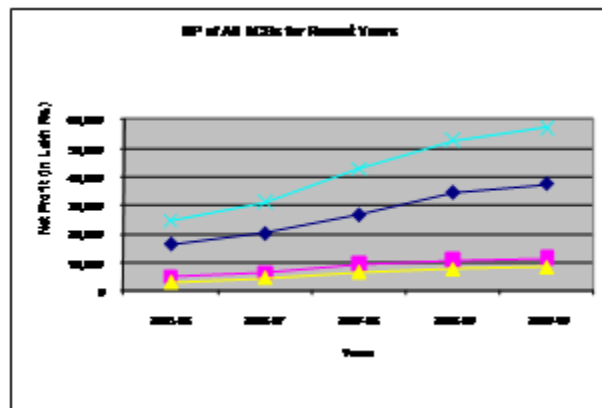
Fig 4: Increased Net Profit of all banks groups in Post-Advent of IT

Years/Groups	PSBs	PrSBs	FBs	SCBs
2005-06	2.22	4.50	13.87	**2.80**
2006-07	2.76	4.71	16.13	**3.49**
2007-08	3.75	6.00	19.47	**4.74**
2008-09	4.70	6.16	25.39	**5.63**
2009-10	**5.34**	**7.19**	**17.09**	**6.05**

Enhanced IT in banking sector has effected positively on each bank group as according to BPE the profitability indicator (Table 3.2). The highest growth is acquired by PSBs from 366.61 (2005-06) to 870.29 (2009-10) i.e. 137% increase in profitability, following by FBs with 51% and PrSBs with 19% respectively. SCBs as a group also showed a noticeable growth from 419.80 in 2005-06 to 873.32 in 2009-10 i.e. 108 %.

Profit Per Employee of Recent Years

Table 3.2: BPE (in lakh Rs.) as 2nd Parameter

Years/Groups	PSBs	PrSBs	FBs	SCBs
2005-06	366.61	670.94	955.41	**419.80**
2006-07	471.18	704.19	974.77	**522.94**
2007-08	600.00	751.42	1037.10	**643.24**
2008-09	734.35	743.85	1282.74	**753.44**
2009-10	**870.29**	**798.37**	**1445.87**	**873.32**

There is an increasing trend because of IT innovations as is reflected in profit per employee (PPE) also. Again top in the ladder is PSBs following by PrSBs then FBs, while the highest value of PPE is showing by FBs (17.09), then PrSBs (7.19) and lowest by PSBs (5.34) respectively. The evidence presents overall growing rate in the values of SCBs as a group i.e. 116%, see table 3.3 with related fig.

Table 3.3: PPE (in lakh Rs.) as 3rd Parameter
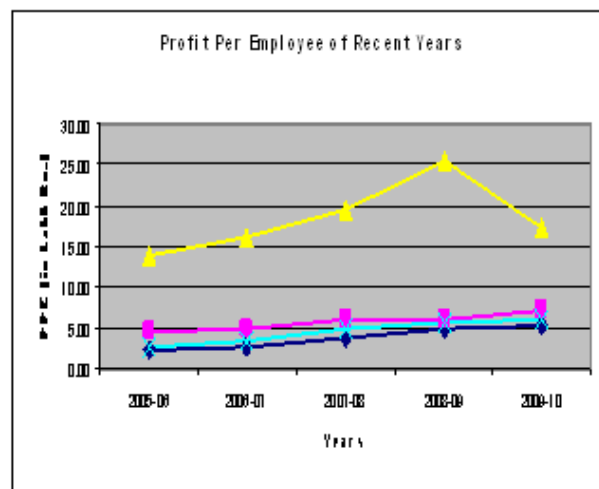
Hence from the analysis it is evident that all SCBs have shown a significant and improving trend in their performance due to the adoption of IT, which leads to acceptance of our hypothesis. Indian banking industry is likely to witness greater propel in this field in coming years with extensive use of IT in their operations.

Hypothesis 2: There is an increase in efficiency in the SCBs after the advent of IT.

The high efficiency scores are taken as a parameter to show an increasing trend of Indian commercial banking industry. The year-wise DEA scores of SCBs operating in India for efficiency measures are summarized in table 4. It clearly shows a consistent mounting trend in the efficiency scores of all SCBs operating in India. For this analysis 4 inputs and 5 outputs are used which are considered the efficiency measures. *Input items* are: Operating Expenses (OE), Staff Expenses to Operating Expenses (SE to OE), and percentage of offsite ATMs to Branches (% of offsite ATMs to Bs) and Expenses incurred on ATMs (Exp. on ATMs). *Output items* are: Business Per Employee (BPE), Total Income per Branch (TI

per Branch), Net Profit to Deposits (NP to Deposits) and Return on Assets (ROA as %).

SCHEDULED COMMERCIAL BANKS (SCBS) (AS GROUP)

In the analysis the DMUs i.e. SCBs which score 1, this rating is considered to be efficient and others considered to be relatively inefficient. Results on efficiency measures by the CCR models (CCR-I and CCR-O) show that SCBs (as a group) are fully efficient in year 2008-09 and 2009-10 while from 2006 to 2008 they had relatively less efficiency. On the other hand, BCC models (BCC-I and BCC-O) find that SCBs are efficiently working in all the years. The efficiency measurement indicates that scheduled commercial banks of Indian banking sector have the proper balance with IT innovations and upgrade electronic systems in banking operations. It is growing in a continuous upward trail in their performance and efficiency level with the passing time.

Table 4: DEA Efficiency Scores of SCBs of India

Years/Model	CCR-I	BCC-I	CCR-O	BCC-O
2005-06	0.942	1	0.942	1
2006-07	0.904	1	0.904	1
2007-08	0.946	1	0.946	1
2008-09	1	1	1	1
2009-10	1	1	1	1

The hypothesis is accepted as the efficiency measures clearly indicate that SCBs of Indian banking sector have the proper balance with IT innovations and upgrade electronic systems in banking operations. It is growing in a continuous upward trail in their performance and efficiency level with the passing time.

Hypothesis 3: IT influx has resulted in higher efficiency level of each bank group.

Group-wise Analysis

In this section we have examined the impact of IT influx individually on each bank group. DEA efficiency scores of each bank group is shown in

following tables , public sector banks efficiency scores in exhibited in table 5, private sector bank efficiency scores in table 6 and foreign banks efficiency scores in table 7 respectively.

PUBLIC SECTOR BANKS

The result shows a fluctuating trend in efficiency scores of public sector banks operating in India. As per CCR models, PSBs are working efficiently in year 2005-06, 2006-07 as the score is 1 which means 100% efficiency and then faced a slight decline till 0.948 in year 2007-08. In next year 2008-09 it increase up to 1 then at last it again fall down at 0.951 in the last year of the study 2009-10. According to BCC models, PSBs are running as fully efficient units in every year with the exception of year 2007-08 (table 5).

Table 5: DEA Efficiency Scores of PSBs of India

Years/Model	CCR-I	BCC-I	CCR-O	BCC-O
2005-06	1	1	1	1
2006-07	1	1	1	1
2007-08	0.948	0.983	0.948	0.983
2008-09	1	1	1	1
2009-10	0.951	1	0.951	1

The explanation suggests that public sector banks made a heavy investment to be IT enabled but still it has to be more concentrated on cost reduction. Business process reengineering and better coordination in different activities and new systems is required to achieve high efficiency in recent competitive environment. Considering the scores analysis aftermath, our hypothesis is accepted i.e. there is increase in efficiency of PSBs operating in India during 2006-10 because of influx of IT.

PRIVATE SECTOR BANKS

The efficiency scores of private sector banks clearly show an increasing trend in the efficiency scores after the advent of IT in the banking operations as shown in table 6 through both the models. In year 2006, 2008, 2009 & 2010 the trend is same via both models. Year 2006, 2009 and 2010 showed 100% efficiency level of private banks, whereas in 2007-08 it presented a decrease in efficiency score. As per CCR model it is 0.959 while by BCC model 0.988 efficiency which is near by 1. The tendency in year

2007 is different in both models as CCR told 0.983 score while BCC recorded 1 efficiency score.

Table 6: DEA Efficiency Scores of PrSBs of India

Taking a holistic view of the picture, our hypothesis is accepted as private banks showed an upgrading level of efficiency after the successful adoption of information technology.

FOREIGN BANKS

The efficiency scores from the analysis clearly indicate foreign banks as leaders with the highest efficient level as 1 in all the years by both the models (table 7). It is clearly shown that foreign banks are the soon familiar with IT innovations as compare to other groups.

Table 7: DEA Efficiency Scores of FBs of India

Years/Model	CCR-I	BCC-I	CCR-O	BCC-O
2005-06	1	1	1	1
2006-07	1	1	1	1
2007-08	1	1	1	1
2008-09	1	1	1	1
2009-10	1	1	1	1

Our hypothesis is accepted after carefully gauging the efficiency scores of foreign banks which shows clearly that they have achieved the top level efficiency after the introduction of information technology in banking area.

CONCLUSIONS OF THE STUDY

As the results show, there is an increasing trend in performance of Indian banks caused by IT innovation and enlarged investment in new information technology during the recent time period (2005-06 to 2009-10). The banks were left with no option but to improve their functional attitude, strategies and policies, efficiently allocating the IT elements with proper guidelines to use them in the presence of required trained staff. Introduction of new technology-based services to their customers, for e.g. e-banking, mobile banking, ATM facility and

card based funds transactions, etc. became a part of their functional norms. The SCBs made heavy investment in technology and computerization of branches from last few years, introduced new services and facilities to the customers which helped the banks to survive in the long run, i.e. to retain

Years/Model	CCR-I	BCC-I	CCR-O	BCC-O
2005-06	1	1	1	1
2006-07	0.983	1	0.983	1
2007-08	0.959	0.988	0.959	0.988
2008-09	1	1	1	1
2009-10	1	1	1	1

their existing customers and attract new ones (RBI, 2010). Taking the whole view, the most efficient banks group is FBs followed by both groups. There is not so much difference in PSBs and PrSBs but as compare in both PrSBs are the best. Hence, Indian commercial banks have improved efficiency and performance after the advent of IT in recent era.

RBI is constantly taking steps to increase the use of IT in the functioning of Indian banks. Recently major initiatives were taken in Electronic Payment Systems with the 'Vision Document' on Payment and Settlement Systems for the year 2009-2012. The document clearly identifies the new frontiers and a road-map for implementation of new projects The vision includes implementation of a new RTGS system which would provide additional features including that for liquidity management, India Money Line – a 24x7 system for one-to-one funds transfers, India Card – a domestic card initiative, redesigned ECS to function as a truly Automated Clearing House (ACH) for bulk transactions, and mobile payments settlement network. The growing trend in the usage of various modes of payment is a clear indication of the momentum acquired in the area of payment systems. The card-based payment systems have been evolving over the period. The card-based payment system in the country covers credit/debit and prepaid cards. About 230 million cards have been issued in the country. We have been witnessing an increase in the usage of cards (debit, credit) across various delivery channels like ATMs, Point of Sale (POS), internet transactions, etc. On an average, 396 million transactions of value one lakh crore are being processed during a month using these cards (RBI, 2011).

The evolving payment systems and other IT enabled culture poses new challenges and opportunities to all segments of this industry. To leverage on the opportunities provided by new products, the system providers/banks need to ensure that the challenges are adequately addressed. It also has to be ensured that the products cover all segments of the population and provide an incentive to adopt these products. The regulatory process would support all orderly development of new systems and processes, within the legal mandate. The challenge before all the stakeholders including banks and non-bank players, IT vendors, other service providers, etc. is how to introduce such a next generation payment and settlement system and solutions that is needed to take the country into the 21st century.

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