

## Evaluating the Efficiency of the Banks in India during the Pre & Post Recession period using DEA Approach

Samyadip Chakraborty

*Doctoral Research Scholar  
Department of Operations and IT  
ICFAI Business School (IBS) Hyderabad, IFHE University,  
Dontanapalli, Shankarpalli Road, Hyderabad – 501203, Telangana, India  
[samyadip.chakraborty@gmail.com](mailto:samyadip.chakraborty@gmail.com)*

### Abstract

This study tries to evaluate the relative efficiency of the Banks in India (all three sections; Public sector, private sector and foreign banks) by classifying them into two distinct groups, namely domestic (Indian public & private banks) and foreign banks. The analysis is carried out using the non-parametric data envelopment analysis (DEA) technique year-wise over a period of 9 years (FY 2001-02 to FY 2009-10) using the output oriented CCR model using 5 input and 5 output factors which are key indicators of banking efficiency. The analysis had been carried out to specifically investigate the fluctuation in the overall relative efficiency of the two groups of banks in the pre and post recession scenario. Findings show that the Indian domestic banks fared well and showed a steep upward trend towards better efficiency while the foreign banks showed certain sign of decreasing efficiency in comparison to the domestic Indian banks.

**Keywords:** Data Envelopment Analysis, Relative efficiency, Banks in India, efficient frontier, operating expense, recession, banking sector, Interest expended, Branches, Employees, ROA, etc.

### Background & Motivation

Over the last two decades plenty of fundamental and regulatory changes have taken place in the Indian banking sector which can be attributed to a large degree to the deregulation regime, the roots of which can be traced back to the opening up of the Indian economy in the 1990s, that gradually led to the creation of an increasingly competitive environment within the Indian banking industry. With the advent of the new millennium India has established itself as one of the leaders amongst the emerging economies with extremely high growth potential. In this backdrop nothing other than the efficiency and robustness of the banking sector gives better understanding and prediction of its future growth trajectory. For any economy, commercial banks are its backbone and its future growth and stability largely rests on the latter. Consequently the survival and success of these banks in a competitive market is highly dependent on continuous improvement and striving for better and higher efficiency and effectiveness leading to the well-being of the whole economy. So measuring the relative efficiency is very vital as it acts as a critical and responsive indicator for

forecasting the trend. It not only helps in getting an early picture of the future success or failure prospects but also helps in analyzing the loopholes and level of inefficiencies of a bank that might have affected its past performances in this highly competitive market. Saha and Ravishankar (2000) stressed that a close observation and careful vigilance of the efficiency indices of the banks could be handy in identifying the areas of banking system inefficiency and help a lot in formulating suitable strategies for improving the banks relative market position. This not only provides a better understanding for the concerned banks but also provides a framework to the regulators for making suitable assessments about the general health of individual banks and work out plans for appropriate interventions, thereby preventing systemic failures. Evidences bear testimony to the fact that everywhere, across the globe, the banking industry has been amongst the first to experience either the impact of financial sector reforms or the effect of financial crisis or slowdown or recession and whatsoever nomenclature the event belong to. Being an emerging economy, India is no exception and ample evidences and statistics from the past incidents like the deregulation of the Indian economy, the policy and regulatory changes across the economy, entry of private banking players, etc provide both empirical as well as anecdotal evidences that the banking sector showed signs of change and adaptation.

India being one of the fastest growing world economies in this millennium has a significant role in financing the process of its planned economic growth. Hence in the backdrop of the world financial crisis of 2006-08, better known as the global recession, how the Indian banking system and its members (public sector, private sector and also the foreign banks having Indian banking establishments) fared in terms of pre and post recession performances and efficiency trend provides a rich scope of study and whether the highly regulated Indian banking sector was indeed affected or not or they rather escaped unscathed needs deeper probing and research.

During the last 20 years several regulatory changes as well as changes as per the world wide banking practices have almost literally changed the anatomy of banks in India and it wont be out of the box to claim that this ever changing banking business environment has been highly successful in attracting the research attention and like several other studies involving worldwide evidences of the impact of deregulation or financial crisis or major financial event that has shaken the world, the impact of worldwide recession in the Asian

markets, especially in the Indian banking perspective offers a big research scope. Several separated studies on the Indian banking sector where either only the public sector or selected private sector banks or at max banks in a specific region have been researched closely in the Indian context using several parametric as well as non-parametric methods. However, most studies were either aimed at post deregulation impact or in analyzing the changing trend in the banking sector and efficiency in India in the backdrop of the entry of private sector banks on the PSBs. But most of them were concentrated between 1986-2006 by various research studies including those of Bhattacharya *et al.*(1997) and Mukherjee *et al.*(2002), Uppal (2006), Aggarwal *et al.* (2007), etc among others. However no detailed study has been done in the recent years during and after the recession era and no significant study especially in the Indian context can be cited which has been carried out involving all the three sector banks (private, public and foreign banks) during the first decade of the millennium when India actually started to express itself in the world as an economic superpower. Moreover India despite being among the world's largest economies is far below the other nations in terms of the ranking of its strongest bank world-wide.

Standing at the juncture of the recession and post recession decade when India is on its unfurling state of growing global in terms of all economic activities and became almost a role model to many western economies for its highly regulated yet successful and robust banking system which stood the brunt of recession, it appears to be justified to have a detailed understanding of the actual measurement of efficiency and general health of the banking system which is the nerve centre of this gigantic economy. Having a clear understanding about the efficiency/performance of banks has become very important for not only managers but also the planners and policy makers because of the fact that banks financial intermediation role and also their efficient performance is directly linked to the real sector gains of the economy.

### **Objective of the Study**

The objective of the study is to measure the relative efficiency of Banks operating in India including all the three segments mainly PSBs (public sector banks), private sector banks and foreign banks operating in India over a period of 9 financial years (FY 2001-02 to FY 2009-10). The attempt of this study is not only finding the most efficient among the players, but also to review the general trend in terms of change in efficiency factor in the backdrop of the recession and thus making an attempt to check whether recession had any specific effect on any specific set of banks. The idea is not only finding the efficiency but also tracing the principle factors behind the inefficiency thereby trying to conceptualize a benchmark for others. This will help the inefficient banks in formulating the strategies so that they can also become equally efficient and remain competitive. Besides this, an attempt has also been made to draw the parallel between the Indian domestic (nationalized & comparable private sector banks) and foreign banks operating in India and thereby trace their distinct efficiency growth trajectory separately as well as in a comparative environment to have an understanding of

how exactly the two sets of banks were affected during these study years and whether each set has acquired or tried to acquire any competitive advantage in terms of optimizing those study parameters.

### **Introduction**

Whenever we discuss about the performance or efficiency of any firm or organization, we try to generally put forward our arguments and discussions mostly in terms of financial indicators and key ratios like ROI (return on Investment), ROCE (return on capital employed), ROA (return on assets), etc. There is no doubt of the fact that these time tested key ratios speak a lot about the current financial standings and efficiency of the concerned firms, but certain inherent limitations and shortcomings also accompany this approach. These ratios generally describe various performance characteristics in isolation because in general for calculating these key ratios, mostly only one input and one output are considered at a time. So the holistic approach or perspective gets somewhat lost and it fails to capture the actual performance or in other words the real-time aspect consisting of multiple inputs and multiple outputs remains missing. Moreover other than the financial perspective, the non-financial face of the organization mainly reflecting in poor or effective management perspective of investment planning or strategic decision making remains highly shrouded and obscure in this traditional approach. An organization might appear to be performing well based on its financial ratio; however it might actually in reality be a poorly managed establishment or firm (Sherman and Gold, 1985).

A vast array of research studies have been conducted by several groups of researchers with a view to reducing these specific problems. One of the best alternative techniques for performance and efficiency measurement that are in practice is the concept of Data envelopment analysis (DEA). It has proved itself to be a powerful benchmarking methodology in those situations where the research study makes use of multiple inputs and outputs while identifying the best practices with an idea of improve the efficiency or productivity of the concerned organizations through careful analysis of the relative efficiency with respect to the market competitors (Zhu & Sherman, 2006). DEA has been used in various instances for comparing and finding the relative technical, operational and production efficiency of firms and organizations across the varied range from hospitals (Banker *et al.*, 1986), schools, logistic providers in one extreme to those of the financial segment like Banks (;Sherman & Gold, 1985; Oral and Yolalan, 1990; Bhattacharya *et al.*, 1997; Ayadi *et al.*, 1998; Golany & Storbeck, 1999; Mukherjee *et al.*, 2002, etc) and Insurance companies (Ennsfellner *et al.*, 2004; Cagil and Karabay, 2010; Barros *et al.*, 2010; etc).

The years following liberalization and specifically the first decade of this new millennium is the era of globalization. Globalization has largely changed the face of Indian banking industry. Many new banks (private sector and also foreign banks) have entered the Indian banking industry, thereby intensifying the competition and all the players are in frantic attempt to increase their market share and remain competitive through enhanced customer service and optimized operations.

The private sector banks and foreign banks with their more customer-centric policies, high quality services, attractive schemes and computerized branches gained the initial competitive edge during the early years of their operation but gradually and steadily the Indian Public Sector Banks (PSBs) have changed their strategies and business outlook according to the changing new environment and have come out challenging their previously advantageous competitors.

This study also attempts to measure the efficiency of the banks operating in India and benchmark them in relation to segments (domestic Vs Foreign) and compare their trends analyzed in the backdrop of the pre and post recession era. The paper is organized as following segments: section 2 presents the literature review and section 3 explains the methodology and choice of Inputs and Outputs. Section 4 is on results and discussions and finally section 5 concludes the paper suggesting the general trends across the years and the implications that might be crucial towards improving the performance of the relatively inefficient banks.

### Literature Review

Since the liberalization and opening up of the Indian economy, Indian financial system and its stepwise reforms and regulatory changes have attracted plenty of research initiatives. Indian banking system and the performance of the Indian commercial banks has entailed quite a few studies both in abroad and in India. However the proportion of studies that have been conducted for evaluating the banking sector of US and other developed countries is much higher than those carried out in the perspective of developing countries. The earliest studies in the Indian banking performance perspective have been carried out by Tygarajan (1975), Rangarajan & Mampilly (1972), Subrahmanyam (1993), etc. However none of the studies looked at the efficiency of the banks. So the subsequent studies had a clear inclination towards efficiency oriented research in the Indian banking domain. Moreover the ownership structure of the Indian banks also offered an interesting aspect of studying the performance sector-wise as the Indian banks can be divided into three segments Nationalized PSBs (Public sector banks), private sector banks and foreign owned banks.

Only 5% of the total research studies concerning efficiency analysis of the financial institutions are conducted on banking sector of developing countries whereas almost 75% of all the researches focused on banking sector of well-developed countries are concentrated only on US market (Berger and Humphrey, 1997). So it becomes clear that the literature on the banking efficiency in the perspective of developing countries like India is no doubt scanty and even if present is mostly focused on the efficiency differentials. Literature on Indian banking industry efficiency is limited and the notable studies include those by Swami and Subrahmanyam (1994), Zaim (1995), Noulas and Katkar (1996), Bhattacharya *et al.*, (1997), Das (1997a, 1997b, 2000), Leighter and Lovell (1998), Saha and Ravisankar (2000), Shanmugam and Lakshmansamy (2001), Mukherjee *et al.* (2002), etc.

Several mention-worthy studies have been done in the past two decades in the international banking context. Seiford and Zhu (1999) in their study examined the performance of top 55

US banks using two-stage DEA approach and their findings indicate that the larger banks fared well in terms of performance on profitability, whereas their relatively smaller counterparts showed better efficiency in terms of marketability. In another western study, in the perspective of efficiency of UK clearing bank branches, Drake and Howcroft (2002) used DEA approach and extended the analysis in the direction of relationship involving size and efficiency. In a contemporary DEA study in the Turkish Banking perspective between 1988 and 1999, Yildirim (2002) indicated that both the technical and scale efficiency measures and scores exhibited large variations and hence concluded that the sector could not attain sustained efficiency gains. Leighter and Lovell (1998) investigated the efficiency of Thai banking industry during the period 1989-1994 and their findings indicate that the average Thai bank gained in productivity gain over the years based on bank's own objectives and also during the same period there was notable productivity gain from the liberalization program as per the government objectives.

Several other notable studies concerning the banking efficiency or to be more precise bank branch efficiency have used DEA approach and notable amongst them are: Manandhar and Tang (2002) who suggested the concept of simultaneous benchmarking of bank branches along the multiple dimensions using modified DEA formulation; seminal studies by Oral and Yolalan (1990) in the Turkish commercial bank sector and empirically measured the operating efficiencies of 20 bank branches of a major Turkish bank using basic DEA principle and concluded that this kind of approach was not only complimentary to the traditional approaches, but all also was highly effective as a management tool in re-allocating resources among bank branches for attaining higher efficiency. Similar several studies concerning the approach towards benchmarking or calculating the branch-wise efficiency have been studied in varied geographies under various scenarios and perspectives. Those vital studies inline with this perspective approach and those that used DEA method were by Sherman & Gold (1985), Berger & Humphrey (1997), Roth & Jackson (1995), Giokas (1991) in the perspective of Greek Banks, Wu *et al.* (2006) in the Canadian bank branch efficiency perspective, etc among others.

Several of these studies have followed directly the DEA approach as prescribed by Charnes, Cooper & Rhodes (1978, 1979) DEA model better known as CCR model (used on the assumption of constant return to scale) or the modified DEA model i.e. the BCC model (incorporating the assumption of Variable returns to scale) by Banker, Charnes and Cooper (1984). However many research studies have used DEA in conjunction with certain other methods to give it a semi-parametric perspective like Simar & Wilson (2007) have described a coherent Data generating process (DGP) and have included the single and double bootstrapping concept along the basic DEA concept. Bhattacharya *et al.* (1997) have used DEA outputs to be fed to the SFA-based (Stochastic Frontier analysis) regression model and computed the findings. In another instance Mostafa (2009) have used DEA in conjunction with neural-network technique to analyze the efficiency of the top Arab banks in the MENA (Middle-East

and North-Africa) region. Such research examples are ample spread across varied geographies.

The earliest instance of bank efficiency analysis in the Indian context was by Luther Committee (1977), examining productivity, efficiency and profitability of the nationalized banks from 1969 to 1975 based on certain specific efficiency indicators. Another attempt covering early years to study the performance in the Indian context is that by Swami and Subrahmanyam (1994) who used 'Taxonomic Method' for studying the inter-bank differences in the performance of PSBs in India during the periods of 1971-73 and 1987-89. They concluded that banks showed disparities in their measures of performance and this became pronounced when differential weighting of individual indicators of business activity were involved. None of the banks were found to perform close to the ideal.

The most prominent among the efficiency studies in the Indian banking context is the one by Bhattacharya *et al.* (1997). They analyzed the impact of liberalization during 1986-1991 and studied the productive efficiency of 70 commercial banks using data envelopment analysis method. They found that the overall efficiency of the PSBs were highest followed by foreign banks and the private banks showed least efficiency. However study results indicate that although the foreign banks initially exhibited slower growth and less efficiency, during the later stage of the study there was a remarkable increase in efficiency of the foreign banks, whereas relatively the PSBs showed a gradual decline in efficiency. However the private banks showed no significant change in their trend. In two more contemporary bank efficiency studies Das (1997a) examined the X-efficiency of Public sector banks in India since nationalization using longitudinal data and their research findings indicates that SBI group banks showed higher extent of efficiency than the other nationalized banks. They concluded that the other non-SBI group PSBs showed greater inefficiency due to certain technical factors and the main reason behind this inefficiency was the underutilization of resources. In another contemporary study Das (1997b) used cross-sectional data of 65 major banks for the year 1995 and used non-parametric frontier method for measuring efficiency. His findings were more of a generalist and concluded Indian banks to be more technically efficient than being allocative efficient. One vital finding of Das (1997b) was that the Indian domestic banks hardly differed across the efficiency measures except scale efficiency between PSBs and private banks. However the foreign banks were reported to be different significantly from public and private sector banks.

In another study in the Indian context covering 68 commercial banks from 1996 to 1999 using DEA, Mukherjee *et al.* (2002) studied their technical efficiency and benchmark performance and their findings revealed that in India the PSBs were more efficient than both private and foreign banks and they showed a trend of improvement in case of the PSBs during the study term. Thus the change in trend becomes visible with the change in the millennium because in a similar research by Bhattacharya *et al.* (1997) a somewhat declining trend was noted for the PSBs towards the end of study period in the early 1990s. These findings are inline to the findings of Noulas and Katkar (1996), which also analyzed the technical

and scale efficiency of public sector banks using DEA and noted that PSBs were operating under increasing returns to scale.

Saha and Ravisankar (2000) in their study with 25 PSBs used DEA approach for the time period from 1991-1994 and concluded that with a few exceptions, PSBs in general have improved in efficiency over the years. Shanmugam and Lakshmanasamy (2001) followed distinct approaches: non-parametric SFA approach, random coefficient approach to measure efficiency and also measured robustness using data on domestic banks in India for the year 1999. They concluded that mean technical efficiency ranged between 52% and 80% in different approaches and they also mentioned that deposits were the dominant factor in determining the output of the banks in all the models. Srivastava (2006) concluded that the post-nationalization period witnessed an unprecedented expansion of banking industry in India.

Uppal (2006) analyzed the profitability of four major bank groups, namely: SBI and its associates, nationalized banks, new private sector banks and foreign banks in the post-reforms era and from the findings concluded a significant difference in the profitability of various major bank groups existed. Profitability was highest in the foreign banks and new private sector banks and the PSBs are far behind in many parameters. However Uppal (2006) conclude that PSBs have a dominant position in terms of their share in total assets of all the scheduled commercial banks. They however urged the need for the PSBs to design more practical strategies to remain competitive in comparison to the new private sector banks and foreign sector banks.

Sooden and Bali (2004) analyzed the profitability of PSBs in the pre- and post banking sector reform periods of 1982-91 and 1992-2000 respectively studying the trends in profitability and factors affecting the profitability of PSBs. They concluded that in the post reforms period, profitability of many PSBs have increased, however at the cost of priority sector lending. Thus they open up a new and interesting debate. The review of literature on banking efficiency in India reflects that none of the above mentioned studies examined the efficiency of the Indian banking sector in terms of Domestic versus foreign banks in the first decade on this millennium keeping into view the worldwide recession and the pre and post recession era. This study aims at understanding this inherent synergy and attempts to identify how far away or how close together have the Indian domestic and foreign banks come in terms of overall efficiency in the face of this global slowdown. This study also attempts to identify the trend in practice in the sector which might be an useful tool for managerial implications for understanding the growth and the robustness of the Indian banking sector as a whole at the threshold of the second decade of this millennium when India is at the verge of its transformation from a developing to a developed nation and the government is planning to launch the Indian banking system as a symbol of India's economic might and strength.

## Methodology

Two well known and most sorted out performance and efficiency measurement methods or approaches that are most

often sort after are the Non-parametric data envelopment analysis i.e. DEA and the parametric stochastic frontier analysis or SFA. Both has its own sets of pros and cons in their usage as efficiency analyzing yardsticks. The other parametric approaches include free disposal hull, thick frontier and the distribution free approaches. However as mentioned by Bhattacharya *et al.*(1997), the non-parametric Data Envelopment Analysis (DEA), is the most suitable and aptly used approach as far as the analysis of the Indian scenario is concerned because the market distortions and sudden changes violates or makes the use of SFA and certain other parametric tool highly confusing and difficult. DEA technique is a linear programming based technique which helps in measuring the relative performance/efficiency of organizational units in the presence of multiple inputs and outputs. Thus it provides a holistic view and also offers all the advantages of any other non-parametric methods. No need to worry about the detailed relationships or the nature of distribution. Initially DEA was proposed to be used for analyzing the performance of non-profit-making bodies or organizations where financial and accounting ratios were of little value. However Sherman and Gold (1985) were the first to use DEA for assessing the efficiency of bank branches. Thereafter DEA turned to be a promising tool for measuring and commenting on the efficiency and overall performance in the banking, insurance and long list of financial and manufacturing sectors. Based on the pioneering works of Farrell (1957), Charnes Cooper and Rhodes (1978) developed the technique first. Though different mathematical programming DEA models have been proposed later with time, the main models involved is the. Charnes, Cooper and Rhodes (1978, 1979, 1981) model, called CCR model which assumed constant return to scale (CRS) and the other being Banker, Charnes and Cooper's (1984) BCC model. In this study the main model being applied is the output oriented CCR model.

In general performance of a bank depends on its ability to utilize the resources to generate business transaction and is measured by the consolidated ratio of the inputs and outputs, which is called efficiency. In DEA efficiency is measured by the ratio of weighted outputs to weighted inputs. The concept of efficiency is highly relevant in the case of banking operations and the literature pertaining to performance evaluation of banks mentions about the various measures of proposed efficiency, namely the scale efficiency, scope efficiency, allocative efficiency, productive efficiency, technical efficiency, etc. (Berger and Humphrey, 1997). Economically, the meaning of efficiency refers to the relationship between scarce factor inputs and outputs of goods and services. The basic concept behind optimized efficiency is that of maximization of output based on the same or constant input or the minimization of input based on the same i.e. constant output. This relationship can be evaluated in terms of physical output or cost.

### Foundations of DEA

DEA is a non-parametric programming model which helps in evaluating the relative efficiency of a set of entities referred to as decision-making units (DMUs) using multiple inputs and

relevant multiple outputs. The DEA approach uses linear programming (LP) model to construct a hypothetical composite unit or frontier. DEA technique helps in identifying the efficient units in a given set of identical or homogenous business units by comparing the observed outputs and inputs. However the efficiency is only relative and not absolute as DEA only identifies the relatively best practicing units to define the virtual efficient frontier and subsequently measure degree of inefficiency for the other units relative to the created frontier values (Oral and Yolalan, 1990). The unit with an efficiency score of 1 (with no slack) is considered to be the most efficient while a score less than one indicates proportionate degree of inefficiency. The relative efficiency in DEA means that the companies are efficient with respect to other companies in the sample. The CCR model and the software used to calculate and generate the DEA scores, adjust the weights for the concerned DMUs so that it becomes relatively efficient. Hence the efficiency score is the weighted set of inputs to the weighted set of output. The CCR model is able to derive a single aggregate score, thereby indicating the performance status of each DMU relative to designated peer group. The DEA model identifies any perceived slack in inputs used or output produced and provides insights into the possibilities of increasing output or conserving inputs i.e. maximization of output or minimization of input in both the cases the other being kept constant.

By calculating the maximal performance measure for each unit relative to other units, the sole criteria that finalizes the units efficiency is whether the unit lays on or below the efficient frontier. Those on the frontier are efficient, while the others off the efficiency frontier are inefficient. Efficiency is measured as the ratio of weighted outputs to weighted inputs and the range lies between maximum of 1 and minimum of zero. In DEA, efficiency means that the firm is a 'best practices' firm in the sample. In this study the following output-oriented Charnes, Cooper and Rhodes (CCR) DEA model was applied to measure the efficiency of banks:

### The CCR model (illustrated below)

Let there be 'n' companies to be evaluated. Each company consumes 'i' different inputs to produce 'r' different outputs. More precisely company 'j' uses  $x_{ij}$  of  $i^{\text{th}}$  input to produce  $y_{rj}$  of  $j^{\text{th}}$  output (where  $j = 1, 2, 3 \dots n$ ). Further it is assumed that  $X_{ij} \geq 0$  and  $Y_{rj} \geq 0$ . The model is formulated as below:

$$\text{Max } E_B = \frac{\{\sum_{r=1}^R u_{rB} Y_{rj}\}}{\{\sum_{i=1}^I v_{iB} X_{ij}\}}$$

Subject to:

$$\frac{\{\sum_{r=1}^R u_{rB} Y_{rj}\}}{\{\sum_{i=1}^I v_{iB} X_{ij}\}} \leq 1$$

For  $j = 1, 2, \dots, n$

$$u_{rB}, v_{iB} \geq \varepsilon > 0 \quad \forall r, i.$$

Where,

$E_B$  = efficiency of a particular company B.

$y_{rB}$  = amount of  $r^{\text{th}}$  output produced by the company B

$x_{iB}$  = amount of  $i^{\text{th}}$  input consumed by the company B

$y_{rj}$  = amount of  $r^{\text{th}}$  output produced by the  $j^{\text{th}}$  company

$x_{ij}$  = amount of  $i^{\text{th}}$  input consumed by the  $j^{\text{th}}$  company  
 $u_{rB}$  = the weight assigned to the  $r^{\text{th}}$  output of the company B  
 $v_{iB}$  = the weight assigned to the  $i^{\text{th}}$  input of the company B  
 $\epsilon$  is a sufficiently small number

The above fractional form can be reduced to the following linear form:

$$\text{Max } E_B = \sum_{r=1}^R u_{rB} Y_{rB}$$

Subject to

$$\sum_{j=1}^n v_{iB} x_{jB} = 1$$

$$\sum_{r=1}^R u_{rB} Y_{rB} - \sum_{j=1}^n v_{iB} x_{jB} \leq 0$$

For  $j = 1, 2, \dots, n$

$$u_{rB}, v_{iB} \geq \epsilon > 0 \forall r, i.$$

### Choice of Input-Output Variables for the DEA of Banks in India

There is a considerable debate in the empirical literature regarding the choice of input and output. The choice of input-output variables in the present study is primarily guided by value added approach (Berger and Humphrey, 1997). In value added approach, banks are treated as service providers, but with a business motif. Hence Deposits (Mukherjee et al., 2002), Interest Income (Ayadi et al., 1998), Other Income (Athanasopoulos, 1997), Investments (Chen & Yeh, 1998) and ROA i.e. Return on Asset (Sakar, 2006) are treated as outputs. This is because these services are linked with the concept of value added. On the other hand the physical resources like Number of offices of the bank (Chen and Yeh, 1998; Sakar, 2006), No. of employees (Sherman & Gold, 1985; Parkan, 1987; Oral and Yolalan, 1990; Vassiloglou and Giokas, 1990), Operating Expenses (Sherman and Gold, 1985; Bhattacharya et al., 1997), Capital Reserve and Surplus (Fukuyama, 1993) and Interest Expended (Bhattacharya et al., 1997) are treated as inputs.

### Choice of Banks (No. of DMUs)

From the detailed literature survey it becomes clear that as far as the Indian Banking sector perspective is concerned though quite a few studies have been done, however majority of these studies are on a very short time horizon (majority 2-5 years) and only a couple of studies exist at a larger time horizon. Hence commenting on the long-run performance of the banks becomes not very dependable based on these studies. Moreover these studies also suffer from some more limitations like the sample size i.e. in this case the number of DMUs being considered. Mostly the studies are carried out not exhaustibly based on only a section of a particular segment of banks and that too are generally small in number. Most studies have been carried out on Public Sector Banks (PSBs) and just a few studies considered section of private banks. However studies contrasting PSBs with Private Banks and Foreign banks are very rare in the recent recession and post recession era in the Indian perspective. The need to include private and foreign banks in the research for performance measurement in terms of efficiency of the Banks in India and to compute a holistic picture becomes even more

vital and evident today as the private sector banks and obviously the foreign banks (though for high value depositors) are giving a tough competition to the public sector nationalized banks operating in India, not only in terms of efficiency and better value addition and high class customer services, but also in generating revenue and higher ROA. So there is an urgent need to evaluate the efficiency of Indian domestic banks (PSBs and comparable private players) in parallel to their foreign competitors who are active in India. There is also a need to separately understand the specific lacunae and loopholes among the domestic banks by segregating the PSBs and the private players and understanding their different trajectories of efficiency growth and individual drawbacks leading to specific inefficiencies.

This study was carried out on a sample of 61 commercial banks in India which includes all three types of banks: PSBs, Private Banks and Foreign Banks (only Indian operations). However for the research analysis these banks have been segregated as Domestic and Foreign. Total 37 domestic DMUs are there (25 PSBs and 12 Private banks) and 24 foreign DMUs. Foreign subsidiaries or foreign collaborations are not included. The bank data for the study are obtained from the Reserve Bank of India's published database for 9 financial years (FY 2001-02 to FY 2009-10). The names of the banks are provided in Table 2.

**TABLE 2: Banks Considered in the study**

Public Sector Banks [PSBs]	Private Banks	Foreign Banks (Indian Operations)
State Bank of Indore	Bank of Rajasthan	Royal Bank of Scotland
State Bank of Travancore	Federal Bank	Abu Dhabi
State Bank of Mysore	HDFC Bank	Commercial Bank
State Bank of Bikaner & Jaipur	ICICI Bank	Arab Bangladesh Bank
State Bank of Hyderabad	ING Vysya Bank	Bank of America
State bank of Patiala	Jammu & Kashmir Bank	Bank of Bahrain & Kuwait
Bank of Baroda	Karnataka Bank	Bank of Ceylon
Corporation Bank	Karur Vysya Bank	Bank of Nova Scotia
Oriental Bank of Commerce	Lakshmi Vilas Bank	Bank of Tokyo
Union Bank of India	South Indian Bank	Mitsubishi
Bank of India	Tamilnadu Mercantile Bank	Barclays Bank
Allahabad Bank	AXIS BANK	BNP Paribas
Canara Bank		Chinatrust
Indian Bank		Commercial Bank
Andhra Bank		Citi Bank
Bank of Maharashtra		DBS Bank
Central Bank of India		Deutsche Bank
Dena Bank		Hongkong & Shanghai Banking Corpn.
Indian Overseas Bank		Mashreq Bank
		Mizuho Corporate Bank
		Oman International Bank
		Societe Generale
		JP Morgan Chase

Punjab & sind Bank		Bank
Punjab National Bank		Krung Thai Bank
Syndicate Bank		Sonali Bank
UCO Bank		Standard Chartered Bank
United Bank of India		State Bank of Mauritius
Vijaya Bank		

## Results and Discussion

Figure.1 shows the year-wise figures for the input factors taken in the study and indicates the major contributing input factors for those years, the excess of which resulted in the inefficiency. These are the figures for the number of domestic banks that showed inefficiency due to the excesses (as obtained from the DEA analysis slack data table) in the input factors for all the 37 domestic banks considered (including PSBs and private sector banks) over a period of 9 financial years (2001-02 to 2009-10). We can find that at the beginning of the study period i.e. 2001-02 the major factors that led to inefficiency of the domestic banks were number of offices, number of employees and operating expenses. Over the entire study period we can find that although a general decreasing trend is clearly visible across all the factors over the years in terms of excesses which is indicative of improvement in efficiency, still number of offices and number of employees contributed the largest proportion of the factors leading to inefficiency. Although operating expenses did not contribute to the inefficiency much since 2002-03 onwards, however a much higher proportionate momentary hike is seen at two specific years 2004-05 and 2009-10. The other factors namely interest expended and capital & reserves & surplus kept low to negligible throughout and even nil at many cases. The general decreasing trend of inefficiency or in other words, the gradual increase in efficiency of the Indian domestic banks is healthy indication of better competitiveness in the Indian banking sector. However the peaking of the operating expense in the 2009-10 can be most aptly be explained as a lagged effect of recession and its negative impact at a large extent. However contrasting these findings with the findings plotted in Figure.2, showing the same year-wise figures for those same input factors for the foreign banks, provides us with a unique understanding. The year-wise graphical plots for the foreign banks shows a very flattened, yet a general upward trend in the inefficiency increment over the same time period. In contrast of the domestic bank outcomes, the operating expense factor for the foreign banks is not a concern of inefficiency. Throughout the time span it had kept medium to nil and on an average very low with exception of just a couple of times. But the major contributors towards increasing inefficiency seemed to be the number of offices and employees during initial study period, however the capital reserve and surplus also seems to be a highly troubling factor for foreign banks in India contributing considerably towards it's inefficiency. Where we see a gradual increase in efficiency of the Indian domestic banks, their foreign counterparts in India seems to losing their position and plunging towards increased proportion of inefficiency. The

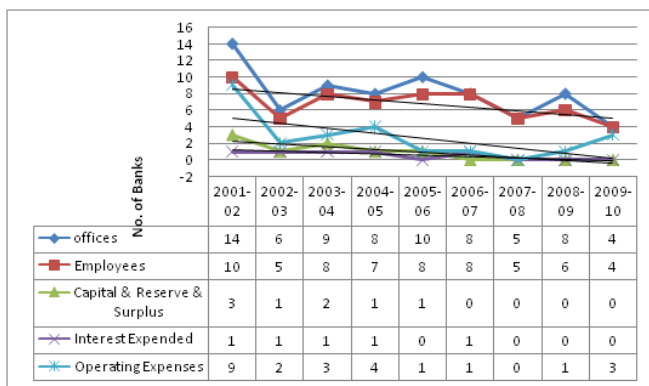
general rise in most of the inefficiency factors towards the end of 2008-09 and 2009-10 can be attributed to the rising levels of tension in the worldwide banking market and this might be a partial reflection of that turmoil that they had to suffer as the parent bodies of major foreign banks faced severe crisis in the other world markets they served.

Taking a look at the shortage slack data (Figure.3) for the domestic Indian banks over the same time period of the study reveals that the shortage based inefficiency trend has also markedly reduced for the domestic Indian banks and they seem to have optimized their output factors namely the deposits, investments, ROA, interest income and other sources of income. Though the proportionate growth and increase in these specific output factors have highly reduced the incidences of shortage oriented inefficiencies, however still inefficiencies exist for certain domestic banks in terms of these output shortages in comparison to the DEA generated virtual most efficient bank on the frontier.

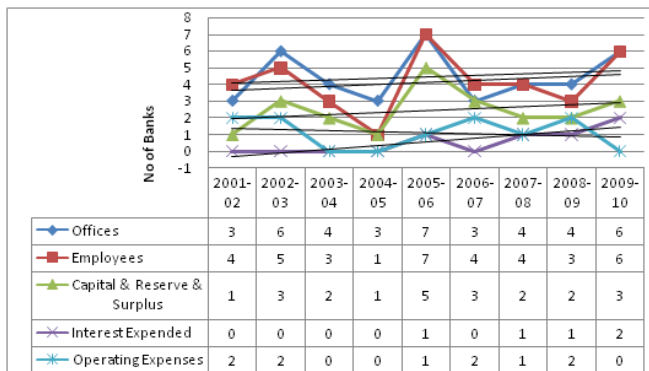
The major factors of concern among the outputs during 2001-02 fiscal were the ROA and Investment. Though investments linked inefficiency reduced markedly in 2002-03 subsequent period, however again in 2006-07 and finally in 2009-10 investment liked inefficiency along with ROA and other income factor has become the main concern. The interest income which used to be the most important for the banks used to be optimized very carefully even during the study start period and even in 2009-10 showed least inefficiency; however the other income aspect has become more important and hence is a growing concern for domestic banks. However the general trend in decreasing inefficiency trend in both input and out related plots for the Indian domestic banks carries a good prospect symptom in general. The upsurge in the inefficiency since 2007-08 might be a reflection of the worldwide banking sector agony during those days of slowdown. But one thing needs to be indicated that for the Indian domestic banks 4 out of the 5 output factors contributed considerably towards inefficiency during the initial study period but over the years despite proportional changes, those same 4 factors with the only exception of the interest income, still seems to be the most important factors of concern. We can see that for the foreign banks the same figures as seen in the plotted graph in Figure.4 seems to be again on a general upsurge trend, indicating that in general for the foreign banks operating in India the shortage-linked inefficiency is exhibited for the chosen output factors over the years, with the exception of the interest income. The factors which started at a lower magnitude during the initial time period of the study spiked once during 2005-06 during the financial market instability and climbed up to almost proportionate higher levels in the period following recession indicating a lagged effect that the shortages might have occurred during the trying time due to their dwindling market reputation and general public apprehension due to their foreign linkages.

On a holistic approach year wise simultaneous plotting of the domestic and foreign efficient banks year-wise in the form of bar charts (Figure.5) indicate that during the study period the domestic Indian banks have gradually become more efficient and the in general efficiency of the foreign banks remained more or less static or slightly dwindling, making it appear relatively creeping downwards. However in order to delve

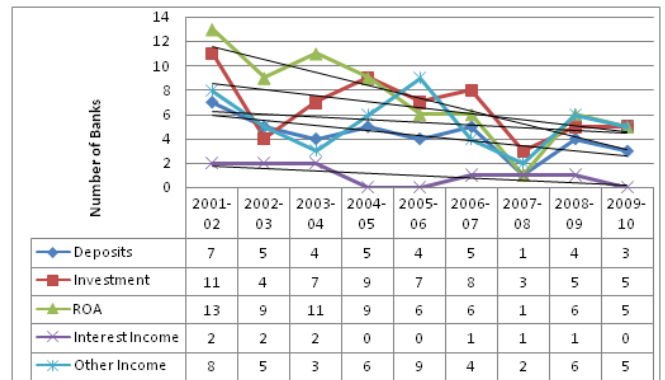
further deep and understand the exact contribution of the composite domestic banks towards efficiency and individualized contributions of the PSBs and the public sector banks, the Indian PSBs and the private sector banks are also similarly plotted in terms of year-wise percentage of the efficient banks (Figure.6) and there another interesting design pattern gets revealed. The trend indicates that it is the Indian nationalized PSBs that had showed a steady upward slope towards becoming efficient year-on-year, whereas the most expected private sector banks actually showed a slight downward sloping tendency. So combining the outputs of all these plots (Fig.1 to 6), it can be said that overall there is a general upliftment in the operations of the Indian PSBs and they have showed remarkable turn-around to achieve continuous higher standards of efficiency whereas the other players i.e. mainly the private players have shown comparatively slower or rather static operations level.



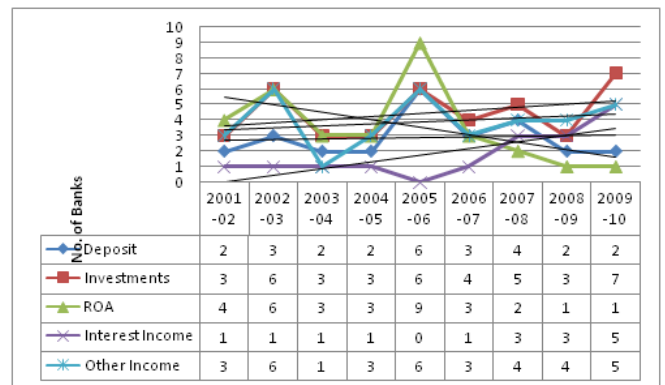
**Fig.1: Domestic Banks: Excesses in the Input Factors leading to Inefficiency (Year-wise)**



**Fig.2: Foreign Banks: Excesses in the Input Factors leading to Inefficiency (Year-wise)**

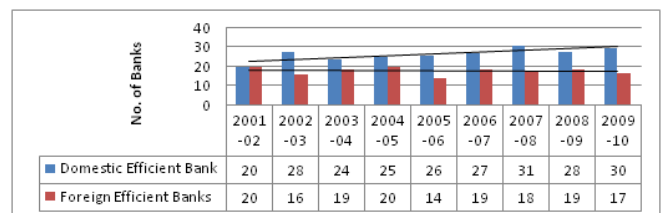


**Fig.3: Domestic Banks: Shortages in the Output Factors leading to Inefficiency (Year-wise)**



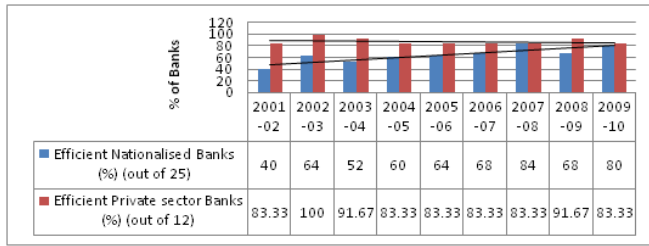
**Fig.4: Foreign Banks: Shortages in the Output Factors leading to Inefficiency (Year-wise)**

Though figures indicate rising efficiency, however relatively that did not seem to be better than that of the PSBs. However on the other hand the foreign banks despite their steady growth have relatively lost the comparative efficiency battle and ended up with a forward sloping year-wise efficiency trajectory. From these empirical findings we can suggest that during the recession years typically, i.e. during the last few years of the study, the common Indian mass might have opted for a safer choice amidst the worldwide turmoil, or it also be the case that the Indian PSBs efficiency drive might have helped them achieve this piece of success despite keen competition and superior infrastructure facilities of their foreign and also their many of the private counterparts in India.



**Fig 5: Year-wise figures of Efficient Banks (Domestic Vs Foreign)**





**Fig.6: Domestic Bank Efficiency (% wise): Public Vs Private Sector Banks**

Thus from the DEA study it becomes evident that for the domestic banks, among the input factors (whose excess presence brings about inefficiency), the main factors that largely result in the inefficiency are mainly the number of offices and the employees. However over the years the general trend appears to be towards more efficient banking practices and the general level of inefficiency has come down as evident from the downward sloping trend-lines as well. Among the output factors (whose shortage signifies inefficiency), the other income variable shows most significant impact in determining the inefficiency of the banks. Off late across the banking domain the income from other sources has become a vital determining factor in deciding the banking efficiency. Though during the initial study years only ROA and Investments showed the maximum impact but from around 2004-05 onwards other income has gained a vital position.

One of the most noteworthy findings is that during 2006-07 the Indian domestic banks as a whole exhibited a general level of upliftment of banking efficiency and hence declining impact of these output factors as it appears that the highly regulated Indian banking system took the necessary measures to optimize the utilization of the factors. However the impact of global slowdown though does not seem to adversely affect the Indian domestic banking efficiency much, but a general rise in the inefficiency trend becomes visible in the last few years of the study when four out of the five output parameters, except the Interest Income component, showed a rising trend. But the overall general trend of the Indian domestic banking sector appears to be towards better efficiency and hence declining inefficiency. The bar diagrams in figure.5 clearly shows that out of the 37 Indian domestic banks (both nationalized & private), in contrast to 20 efficient banks in 2001-02, 30 efficient banks out of the same sample can be seen in 2009-10. Now by what proportion and to what extent the nationalized banks in contrast to the private sector banks in the Indian domestic banking sector, worked efficiently, gives a scope of the next stage and level of investigation. It's really intriguing to find that the average relative efficiency of the nationalized banks grew at a much faster level year on year in majority of the cases. However exceptions do exist among both the sets of banks which were either ahead or behind their group averages. But it won't be out of the box to justify from the findings that although the trend says that the PSBs became much more efficient but all these are just average relative year on year growth figures and must not be quantified in absolute terms. Hence although the relative

average efficiency of the PSBs grew at a higher rate, it is not indicative of the absolute efficiencies and cannot directly be used to say that the PSBs are more efficient in absolute terms. The tables 3a & 3b shows the average figures in terms of efficiency scores over the years and the standard deviation for the domestic and the foreign banks respectively. It can be seen that the average relative efficiency scores for the domestic banks in India has always hovered around the 97-99% mark and the standard deviation scores for the domestic banks are very less whereas from the table 3b it can be seen that the average relative efficiency scores for the foreign banks are a bit lower and around on an average 96-97% with higher values for standard deviation. This shows that the PSBs are more concentrated towards the ideal efficiency figures whereas the foreign banks seem to be much disparately spread. So this gives us an idea about the consistent upward efficiency trend for the domestic banks whereas a somewhat unstable and inconsistent average pattern for the foreign banks having operations in India. The minimum efficiency for any foreign bank year-wise right throughout the time period ranges in the range of 70% whereas it is much higher in the 90% range for the domestic banks. So we can state that the foreign banks showed much variability in terms of relative efficiency across the time period.

**TABLE.3 (a & b): DEA Output: Domestic (a) Vs Foreign Banks (b)**

<b>Domestic banks</b>		<b>Number of DMUs = 37</b>								
<b>Stats at a glance</b>		<b>2001</b>	<b>2002-</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
		<b>-02</b>	<b>03</b>	<b>-04</b>	<b>-05</b>	<b>-06</b>	<b>-07</b>	<b>-08</b>	<b>-09</b>	<b>-10</b>
<b>Average</b>	0.973	0.989	0.982	0.983	0.990	0.989	0.995	0.993	0.995	0.995
<b>ge</b>	472	495	541	908	454	987	586	615	248	
<b>SD</b>	0.049	0.027	0.035	0.032	0.019	0.023	0.014	0.015	0.014	0.014
	322	3579	435	612	054	678	041	077	036	
<b>Maxi mum</b>	1	1	1	1	1	1	1	1	1	1
<b>Mini mum</b>	0.804	0.862	0.851	0.851	0.931	0.880	0.920	0.931	0.923	0.923
	096	8124	577	198	824	463	898	707	794	

<b>Foreign banks</b>		<b>Number of DMUs = 24</b>								
<b>Stats at a glance</b>		<b>2001</b>	<b>2002-</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
		<b>-02</b>	<b>03</b>	<b>-04</b>	<b>-05</b>	<b>-06</b>	<b>-07</b>	<b>-08</b>	<b>-09</b>	<b>-10</b>
<b>Average</b>	0.979	0.956	0.969	0.983	0.936	0.983	0.959	0.976	0.965	0.965
<b>ge</b>	03	889	113	706	921	47	503	984	698	
<b>SD</b>	0.068	0.079	0.071	0.039	0.092	0.043	0.078	0.062	0.074	0.074
	985	7707	501	182	005	569	27	367	934	
<b>Maxi mum</b>	1	1	1	1	1	1	1	1	1	1
<b>Mini mum</b>	0.667	0.711	0.752	0.849	0.672	0.833	0.768	0.733	0.700	0.700
	341	0259	237	462	379	831	443	53	113	

This study also contrasts the efficiency of the domestic banks against their foreign counterparts and how differently or similarly the same input and output factors affect the domestic and the foreign banks in the same Indian market provides an

interesting scope of research. Another aspect that needs to be analyzed is the average yearly figures for the domestic and foreign banks. The table 4a shows the average figures for the domestic banks across the time period. For the domestic banks the number of offices have increased steadily, however the number of employee growth year-on-year had been proportionally slow but steady [Table 4(a)]. This might be attributed to the various voluntary retirement schemes and golden shake-hand options offered by the nationalized banks. This might also be an indication that this might have been an attempt at reducing the extra employees by not fully replacing all the retired or voluntarily retired employees and thus making the banks more efficient. The average number of offices increased almost 30% during the study time period whereas the average number of employees increased at 14.5%. As per most of the bank annual reports and statements the main objective of the banks is to increase its deposit and return per employee. So this offices and employees issue that had been a real factor contributing to the domestic banks inefficiency largely had been given priority and addressed carefully. Over the years the deposit has increased at about 4.23 times whereas the interest expense has increased at 3.46 times. The capital and reserve and surplus has increased almost 5 folds almost inline with the increase in the deposits and stringent reserve bank of India (RBI) regulations. The main point of interest and which might be an indicative of improvement in banks efficiency is the increase in the income of the domestic banks from other sources referred as other income. Generally the proceeds from NPA (non performing assets) recovery and also the earnings from other value added services like ATM transaction charges, phone and net banking charges, banking services transaction charges, credit card services and related charges, etc. This has increased steadily (3.3 times) for the domestic banks almost at par with that of their foreign counter parts for whom in the mentioned timeframe earnings from other income has increased at 3.5 times. It is observed from the tabulated year-wise figures that the average ROA of the Indian domestic banks have remained almost stable and hovered around 1.0 which is commendable keeping in mind the strict priority sector lending and the agricultural lending regulations set by RBI for the Indian domestic banks, which though present in case of priority sector for the foreign banks is much relaxed and almost nil in agriculture sector. The main item that draws the attention is the overall decrease in the operating expenses. In 2001-02 the average operating expenses were 2.7% of the yearly deposit for the domestic banks, which has reduced to 1.9% in the 2009-10 annual figures. Referring to the figures from the table 4(a) it is found that the average deposit per offices for the domestic banks taken together increased from 19.45 crore (INR) in 2001-02 to 61.34 crore (INR) in 2009-10 (almost 3 times) and average deposits per employees for the domestic banks taken together increased from 1.37 crore (INR) in 2001-02 to 5.1 crore (INR) in 2009-10 (almost 3.7 times). [1 crore(Cr) =10 million; crore is an Indian unit of representing numbers]

**TABLE.4 (a & b): Domestic (a) Vs Foreign Banks (b)  
(Avg. Figures Year-wise)**

Average Domestic Bank Figures	Offices	Employees	CR & S	Int. Exp	Operation. Exp	Deposits	Investment	ROA	Int. Inc	Other Income
			(IN R Cr)	(IN R Cr)	(INR Cr)	(IN R Cr)	(INR Cr)		(IN R Cr)	(INR Cr)
2001-02	112 5.54	15950 .92	148 0.30	152 9.43	580.2 4	2188 1.16	10386 .11	0.9 0	2187 .05	407.8 6
2002-03	113 9.14	16127 .54	170 3.44	171 9.73	676.5 7	2510 0.97	12305 .08	1.1 4	2545 .43	571.0 5
2003-04	115 4.05	16164 .97	206 1.33	163 6.11	772.8 9	2917 7.32	15245 .86	1.3 1	2639 .76	705.7 6
2004-05	118 0.19	16223 .32	258 1.25	166 2.38	893.6 5	3517 6.05	15642 .57	0.9 0	2835 .51	594.0 8
2005-06	119 5.35	16531 .16	320 9.95	199 1.19	1015. 57	4235 4.49	16157 .86	0.8 9	3341 .11	618.3 5
2006-07	126 6.59	17063 .43	374 9.43	275 2.03	1164. 49	5342 6.54	18143 .49	1.0 1	4386 .19	718.8 6
2007-08	134 0.30	17699 .30	531 2.45	405 5.62	1339. 55	6505 2.62	22015 .80	1.0 6	5820 .31	1004. 46
2008-09	142 3.76	18023 .59	623 5.99	514 5.37	1550. 57	7871 7.29	25941 .97	1.0 4	7368 .46	1203. 78
2009-10	151 2.11	18262 .32	734 7.73	529 5.22	1709. 43	9274 8.41	31258 .43	1.0 0	7887 .16	1327. 03
Average Foreign Bank Figures	Offices	Employees	CR & S	Int. Exp	Operation. Exp	Deposits	Investment	ROA	Int. Inc	Other Income
			(IN R Cr)	(IN R Cr)	(INR Cr)	(IN R Cr)	(INR Cr)		(IN R Cr)	(INR Cr)
2001-02	7.25	409.1 3	355 33	204. 71	108.7 1	2275 .63	1253. 39	130 .90	331. 04	110. 04
2002-03	7.71	485.0 0	498. 17	191. 67	121.3 8	2693 .75	1591. 58	1.5 7	344. 29	116. 50
2003-04	8.33	532.0 0	562. 67	164. 50	142.5 4	3153 .21	1647. 46	1.8 0	356. 88	150. 33
2004-05	9.46	649.6 7	740. 63	157. 42	168.7 9	3441 .21	1690. 75	0.6 6	363. 38	149. 00
2005-06	10.1 7	794.5 0	951. 67	202. 54	219.0 8	4620 .58	2163. 29	1.5 8	491. 17	199. 13
2006-07	10.5 8	1094. 63	130 8.79	304. 50	304.5 8	6126 .58	2846. 29	1.8 4	724. 75	270. 75
2007-08	11.1 3	1371. 46	199 8.83	434. 31	425.8 8	7900 .44	4048. 17	2.4 6	100 2.06	430. 54
2008-09	11.7 1	1187. 96	240 0.25	521. 49	490.4 1	8835 .81	5234. 86	2.5 9	124 0.48	595. 06
2009-10	12.2 1	1108. 46	270 9.88	365. 08	439.8 3	9802 .08	6372. 38	1.4 6	107 5.79	389. 46

In contrast to the domestic banks [Table 4(b)] the foreign banks showed a reverse trend as far as their growth over the years in terms of number of offices and employees were concerned. Just as the domestic banks were trying to become slim in terms of employees, the foreign banks increased their average number of offices by 68% over the years, whereas the number of employees increased by 170%. These two figures indicate that the foreign banks were gradually consolidating in the Indian business perspective and it can be said that gradually the domestic and foreign banks were trying to compete for the share of the plum. So in terms of operations their differences diminished. While the foreign banks were keen at business expansion and maintenance of their standards, the Indian domestic banks were trying to become efficient and more competitive in several aspects in comparison to their foreign counterparts. The average operating expenses for the foreign banks also decreased but marginally from 4.7% of the average yearly deposits in 2001-02 to 4.5% in 2009-10. Referring to the figures from the table 4(b) it is found that the average deposit per offices for the foreign banks taken together increased from 313.9 crore (INR) in 2001-02 to 802.8 crore (INR) in 2009-10 (almost 2.5 times) and average deposits per employees for the foreign banks taken together increased from 5.56 crore (INR) in 2001-02 to 8.84 crore (INR) in 2009-10 (almost 1.6 times). Both of this in comparison to the domestic players is not that great because one fact must be kept into mind that the Indian domestic banks have a large share of their offices and infrastructure devoted for the rural Indian market which is not very highly lucrative in terms of gain. Despite that, domestic figures are commendable. A downward trend in the ROA of the foreign banks is a vital aspect to be noted.

We can see that for the domestic banks the Interest expenditure as % of deposit had hovered roughly around 7% mark in the initial time-period but gradually came down in the years following and again peaked slightly almost at the corresponding time to that of the global slowdown but again eased it down to a mark of around 6%. In contrast to this the similar figures of the foreign banks are quite interesting. Though they were at a much less advantageous position as far as this interest expense is considered at the starting time period, but they gradually and steadily brought it down. Though in a similar pattern as observed for the domestic banks a peaking in the figures is observed at about the same time of the recession, however they brought it down to even lower levels in the final stage of the study time period to as low as 3.7%. So in terms of interest expended the foreign players showed a much higher efficiency increment. But the over all average relative efficiency fluctuation for the foreign banks as mentioned before was of much greater magnitude in comparison with the Indian domestic banks and that too heightened during the recession years. Thus raises a question about the vulnerability. However it should be noted at this position that the over Indian banking sector as a whole had carefully controlled its interest expenditure during its quest towards an efficient system. Although the interest expense has massively reduced for the foreign banks, their interest income and other income figures have also reduced to a large extent which is not a very healthy symbol and this might be attributed to the lagged effect of the recession years as the

proceeds of the banks and the earnings represent last years performances. 2009-10 is the time period when the world had just come out of the recession and was not very stable, hence the majority of the risk averse Indian population still favored and relied on the highly regulated and nationalized Indian banks and also domestic private banks. Further deeper study with the subsequent yearly figures will be able to explain this trend in many details, and whether the hunch that is appearing is legitimate or not can be justified.

Now to be specific with the findings, while for the major two factors i.e. number of offices and number of employees, certain nationalized banks like Allahabad bank, Canara Bank, Indian Bank, Punjab National Bank, Punjab & Sind Bank, United Bank of India, etc showed repeated instances of inefficiency over the years in terms of their number of employees and a somewhat larger list including BOB, Andhra Bank, Vijaya Bank including the latter set for the number of offices related input. Even few private banks showed inefficiency namely ING Vysya, South Indian Bank, Lakshmi Vilas Bank, etc in terms of number of offices and number of employees. However for the other three input variables, defining efficiency all throughout the period, less nationalized banks were found to be affected. But still in case of operating expenses few similar names which have been repeatedly affected come up, like Indian bank, Allahabad bank, Dena bank and ING Vysya among the prominent few. The detailed list of the year-wise inefficient domestic and foreign banks are provided in the tables 5 and 6 respectively. The codes along with the names and details are available in Appendix 1.

Certain banks had remained efficient almost consistently over the years with an exception of one or two for a particular year or so. The main consistent domestic banks among the public-sector banks has been Bank of India, Indian Overseas Bank, UCO bank, Oriental Bank of Commerce, State Bank of Indore, State bank of Travancore, State bank of Patiala, etc. Among the private-sector banks, the major names that has been consistent in terms of efficiency almost throughout the study period are the Federal Bank, HDFC Bank, ICICI Bank, AXIS Bank (previously UTI Bank), Jammu & Kashmir bank, Karnataka Bank, Karur Vysya Bank, Tamilnadu Mercantile bank, etc. The study results clearly sow imply that the performance of HDFC Bank, ICICI Bank, Axis Bank are much better than the other domestic competitors and are the topmost private banks. Among the foreign Banks the most impressive and 100% efficient (relatively) across all the years were CITI BANK, DEUTSCHE BANK, DBS Bank, Barclays Bank, Royal Bank of Scotland (Previously ABN AMRO) etc. Other prominent banks like HSBC showed inefficiency in the early years whereas Standard Chartered Bank showed signs of inefficiency during the recession years. Rest of the time they were highly successful and efficient. The other banks namely Oman international Bank, Bank of Bahrain & Kuwait, BNP Paribas, Societe Generale, Chinatrust Commercial Bank, etc showed almost consistent inefficiency. Thus segregation between the efficient and inefficient banks among the foreign sector banks is wide. Those showing efficiency were almost consistently efficient while the other were repetitively inefficient. This leaves a scope of further research and studying. However the gap between the relatively efficient and inefficient banks is not that distinct in the case of the

Indian domestic PSBs. However the private domestic banks show a very consistent pattern.

Looking at the year-wise tables of the list of inefficient domestic and foreign banks a pattern gets clearly revealed. There are two sets of banks existing in India, those that have taken the aspect of efficiency as a learning curve or as a competitive differentiation factor and the others those who have not been able to reap gain from the learning experience and have failed to formulate their own business policies or position themselves strategically so as to turn their operations into an efficient and competitive enterprise and have remained inefficient due to the lacking in some thing or the other among the indicative factors chosen for the analysis study during the time-period.

**TABLE.5: Year-wise list of Inefficient Domestic Banks**

	2001-02 [17]	2002-03 [9]	2003-04 [13]	2004-05 [12]	2005-06 [11]
<b>CB I</b>	0.9983 5	<b>CBI</b> 0.9901 68	<b>BO M</b> 0.9974 82	<b>SYB</b> 0.9940 34	<b>VJ B</b> 0.9978 89
<b>UN B</b>	0.9969 35	<b>UN B</b> 0.9866 23	<b>AN B</b> 0.9959 82	<b>SBI</b> 0.9866 46	<b>SB H</b> 0.9893 07
<b>AL B</b>	0.9964 93	<b>CA B</b> 0.9860 09	<b>AL B</b> 0.9912 45	<b>BO B</b> 0.9831 7	<b>PN B</b> 0.9892 05
<b>SB T</b>	0.9912 1	<b>SB B</b> 0.9802 44	<b>CBI</b> 0.9785 01	<b>UN B</b> 0.9785 12	<b>OB C</b> 0.9862 96
<b>PN B</b>	0.9847 76	<b>AL B</b> 0.9790 1	<b>IN G</b> 0.9700 28	<b>ALB</b> 0.9695 54	<b>PS B</b> 0.9860 06
<b>VJ B</b>	0.9841 03	<b>BO B</b> 0.9643 25	<b>CA B</b> 0.9663 88	<b>DE B</b> 0.9662 56	<b>SIB</b> 0.9684 28
<b>AN B</b>	0.9740 9	<b>DE B</b> 0.9519 9	<b>UN B</b> 0.9618 5	<b>ING</b> 0.9583 69	<b>IN G</b> 0.9603 44
<b>CO B</b>	0.9729 58	<b>UBI</b> 0.9101 35	<b>BO I</b> 0.9598 09	<b>CA B</b> 0.9508 61	<b>BO M</b> 0.9559 6
<b>BO B</b>	0.9710 44	<b>INB</b> 0.8628 12	<b>CO B</b> 0.9504 47	<b>PN B</b> 0.9486 68	<b>BO B</b> 0.9431 62
<b>CA B</b>	0.9690 04		<b>BO B</b> 0.9503 86	<b>INB</b> 0.9209 44	<b>AL B</b> 0.9383 62
<b>BO R</b>	0.9584 27		<b>IN B</b> 0.9125 22	<b>BOI</b> 0.8963 97	<b>AN B</b> 0.9318 24
<b>UC O</b>	0.9130 64		<b>UB I</b> 0.8677 92	<b>LVB</b> 0.8511 98	
<b>DE B</b>	0.9054 97		<b>SB B</b> 0.8515 77		
<b>UB I</b>	0.8873 43				
<b>IN G</b>	0.8803 97				
<b>SB B</b>	0.8306 85				
<b>IN B</b>	0.8040 96				
	<b>2006-07 [10]</b>	<b>2007-08 [6]</b>	<b>2008-09 [9]</b>	<b>2009-10 [7]</b>	
<b>SBH</b>	0.9986 11	<b>ALB</b> 0.990833	<b>SIB</b> 0.9932 72	<b>UNB</b> 0.992824	

<b>INB</b>	0.9930 14	<b>ANB</b>	0.989275	<b>INB</b>	0.9931 87	<b>BOI</b>	0.992796
<b>SBI</b>	0.9850 79	<b>SIB</b>	0.984728	<b>ALB</b>	0.9898 82	<b>CAB</b>	0.98473
<b>BOM</b>	0.9804 03	<b>CAB</b>	0.983316	<b>CAB</b>	0.9844 24	<b>SIB</b>	0.984545
<b>ANB</b>	0.9731 6	<b>PSB</b>	0.967636	<b>UBI</b>	0.9839 92	<b>VJB</b>	0.984052
<b>CAB</b>	0.9664 92	<b>LVB</b>	0.920898	<b>ANB</b>	0.9757 08	<b>IOB</b>	0.961432
<b>PSB</b>	0.9660 84			<b>IOB</b>	0.9613 9	<b>LVB</b>	0.923794
<b>ALB</b>	0.9474 49			<b>VJB</b>	0.9501 85		
<b>ING</b>	0.9387 49			<b>SBM</b>	0.9317 07		
<b>LVB</b>	0.8804 63						

**TABLE.6: Year-wise list of Inefficient Foreign Banks**

	2001-02 [4]	2002-03 [8]	2003-04 [5]	2004-05 [4]	2005-06 [10]
<b>HSB C</b>	0.992 029	<b>HSB C</b> 0.979 556	<b>BOA M</b> 0.993 061	<b>CHT C</b> 0.938 726	<b>BOC L</b> 0.957 305
<b>BNP P</b>	0.938 859	<b>BOT M</b> 0.925 913	<b>BOC L</b> 0.896 524	<b>BOB K</b> 0.929 591	<b>MSR B</b> 0.948 445
<b>OMI B</b>	0.898 499	<b>BNP P</b> 0.919 84	<b>BNP P</b> 0.814 305	<b>OMI B</b> 0.891 176	<b>BOA M</b> 0.916 958
<b>SOC G</b>	0.667 341	<b>BOC L</b> 0.910 265	<b>BOB K</b> 0.802 595	<b>BNP P</b> 0.849 462	<b>CHT C</b> 0.888 482
		<b>OMI B</b> 0.901 687	<b>OMI B</b> 0.752 237		<b>SOC G</b> 0.875 38
		<b>BOB K</b> 0.880 789			<b>BOT M</b> 0.838 393
		<b>MZ CB</b> 0.736 261			<b>BNP P</b> 0.819 124
		<b>SOC G</b> 0.711 026			<b>MZ CB</b> 0.801 11
					<b>BOB K</b> 0.768 517
					<b>OMI B</b> 0.672 379
	<b>2006-07 [5]</b>	<b>2007-08 [6]</b>	<b>2008-09 [5]</b>	<b>2009-10 [7]</b>	
<b>MZ CB</b>	0.988 965	<b>BNP P</b> 0.946 127	<b>BNP P</b> 0.982 64	<b>CHT C</b> 0.990 665	
<b>ARB B</b>	0.982 755	<b>BRC L</b> 0.921 748	<b>KRT B</b> 0.981 25	<b>ABC M</b> 0.961 722	
<b>BNP P</b>	0.941 441	<b>CHT C</b> 0.810 322	<b>STC B</b> 0.915 118	<b>BOB K</b> 0.951 609	
<b>OMI B</b>	0.856 279	<b>SB MT</b> 0.799 911	<b>OMI B</b> 0.835 071	<b>OMI B</b> 0.916 862	
<b>CH TC</b>	0.833 831	<b>OMI B</b> 0.781 521	<b>CHT C</b> 0.733 53	<b>KRT B</b> 0.866 753	

		<i>MZ</i>	0.768			<i>MZ</i>	0.789		
		<i>CB</i>	443			<i>CB</i>	029		
						<i>SB</i>	0.700		
						<i>MT</i>	113		

### Conclusion & Implications

The interesting observation of the current study is that contrary to the popular belief that the foreign banks are very efficient and the domestic nationalized banks lack in those capabilities is not necessarily the belief to be kept. Profitability studies have showed that domestic banks have rapidly come closer to their foreign competitors and rather surpassed them during the crisis years by attracting enormous deposits & business through better efficient services and operations. The previous studies of Bhattacharya et al.(1997) traced the foreign banks to be gaining efficiency very fast and the domestic banks lagging behind, but just almost a decade of Indian banking sector competition and regulation has reversed the scenario completely and the gap is now increasing in the reverse sense, the foreign banks catching up the Indian domestic banking players. The recession has rather created the background contrast that has in turn highlighted the growing efficiency and steady stable aspect of the Indian domestic banks. Its obvious that both the foreign and domestic sector players as far as the Indian banking scenario is concerned faired well but however the ripples of the western world had affected the foreign banks relatively much more than that had affected the domestic banks. The domestic banks have rather accelerated their growth trajectory towards higher efficiency in this backdrop under the stringent regulations and control of the Reserve bank of India.

So it can be concluded that though both the sets of banks on an average have become efficient to a large extent, but in terms of the efficiency trajectory the upward trend for the domestic banks is much steeper indicating and the variations minimal, indicating a healthy growth pattern towards excellence and sustainability. The recession has not been able to dent the efficiency of the Indian domestic banks, however the foreign banks have become somewhat affected the overall return on asset and also brought in certain level of variability. The main endeavor of this study was to find the continuation of the findings by the previous studies across the three categories involving domestic public sector, private sector and foreign banks in India. What the studies in the last decade of the previous millennium and the early years of this decade indicated, whether that trend has flipped or reversed was the main aim. The findings of this study indicate that the efficiency growth both in terms of general and operations efficiency has changed its side. The previously lagging public sector bank in the face of steep competition of foreign and efficient private sector players have ventured towards a journey of constant cravings for higher efficiency and have re-positioned themselves newly as highly efficient and competitive players. The private players which had been efficient since inception have lined up for a better chance. However the foreign banks who were previously looked up as leaders of efficiency have slowed down, rather the slope towards efficiency has minimized and even the general

relative trend and data findings make it appear to be becoming less efficient in relative comparison and not absolute terms.

It can be concluded that the perceived gap that the literature previously supported and claimed to be existing in between the foreign and domestic public sectors banks in the Indian perspective has narrowed down largely.

The major implications and findings that need to be carried are: firstly the Indian public and private sector banks have immense scope to capitalize on this present trend and their current overall efficient standings. Despite having large responsibilities in terms of priority lendings, rural presence, agricultural mandatory loans and strict RBI guidelines regarding NPAs and lending policies, the Indian domestic public and private-sector banks have exhibited tremendous prospect in terms of potential to grow and remain competitive not only in the domestic market, but also venture to newer markets and compete at global levels. Second important implication is that given the present backdrop and standings of the Indian domestic banks as a whole, this offers a ripe opportunity to venture with global standards and take a competitive advantage ahead of the foreign banks and thus consolidate the Indian banking sector as a benchmark of best practices while remaining true at its basic endeavor of sustainable social benefit enhancement and generative growth. The Study reveals that the private sector banks and public sector banks were found to have become largely efficient. Though the private banks showed greater extent of efficiency, however despite shouldering the key social responsibilities the PSBs seemed to have gradually enhanced their productivity and efficiency largely and the gap has narrowed between the domestic and foreign banks. Certain managerial implications however if followed by the PSBs will lead to even better efficiency and those suggestions that comes up in course of this analysis through comparison with the foreign banks are:

- -Designing more efficient plans to enhance non interest earning i.e. other income.
- -Grow even more lean through more effective mapping of human resources and this would help reduce the slack caused by improperly utilized resources; thereby enhancing efficiency and productivity.
- -Increasing the range of Value added services like ATM facility, locker facility and credit cards, etc. These are the main differentiating factors between most of the Foreign and private banks with the nationalized PSBs.
- These activities lead to more and more non-interest income growth. IT infrastructure optimizations and proper training will lead to benchmarking of even more effective operations and minimize operating cost; thereby enhancing operations and cost efficiency. PSBs should aim at reducing the NPAs through stringent control mechanisms and credit history checking and try to differentiate itself through unique product designing like unique deposit schemes targeting different segments as per their needs. Thus unique market segmentation and positioning will help the Indian domestic banks to perform more effectively and efficiently. The PSBs no doubt being on the trajectory of high efficiency

growth must implement certain agenda changes and form key policy initiatives vision-mission-value propositions which will help them to be more productive. Especially those PSBs which consistently showed signs of inefficiency can be transformed into more competitive and efficient enterprises. In terms of productivity foreign banks were no doubt the highest, but also had the highest costs involved. But the Indian domestic banks, especially the private banks replicated similar excellent growth records but in the cost effective manner, reducing their operating cost and maximizing profitability. Though PSBs have the lowest costs of operations but other income and proportionate interest income is also much below the expected level of competitiveness. So from a holistic perspective though the recession did not affect the business pattern of the Indian PSBs adversely, lack of competitive strategies still a weak link in the strong regulated Indian banking chain.

### Limitations & Future Scope of Study

There remains the need for in depth further comprehensive research for the subsequent time period so as to understand any related lagged impact of the recession that might not have been visible in this limited post recession time horizon. Another major limitation of the study was that the research perspective and scope had been limited to only those indicative factors related to efficiency that was available in the Reserve Bank of India published Bank data. Several others despite being critical for estimation and analysis of banking sector efficiency could not be incorporated. Moreover the model only considered the data analysis from the perspective of CCR model under the assumption of constant returns to scale. There remains enough scope to justify the similar study in future from the perspective of other allied advanced DEA models and that might give a new dimension or a more critical study perspective.

### References

- [1] Aggarwal, A. K., Singh, D. and Chaturvedi, N. (2007-08). India's Banking Sector Consolidation and Convergence: Balancing on the Brink? *Punjab Journal of Business Studies*, Vol. 3, No. 2, pp. 39-46.
- [2] Al-Faraj, T., Alidi, A. and Bu-Bshait, K. (1993). Evaluation of bank branches by means of data envelopment analysis. *International Journal of Operations & Production Management*, Vol. 13, No. 9, pp.45-52.
- [3] Al-Shammari, M., and Salimi, A. (1998). Modeling the operating efficiency of banks: A nonparametric methodology. *Logistics Information Management*, Vol. 11, No. 1, pp. 5-12.
- [4] Athanassopoulos, A. (1997). Service quality and operating efficiency synergies for management control in the provision of financial services: Evidence from Greek bank branches. *European Journal of Operational Research*, Vol. 98, No. 2, pp. 300-312.
- [5] Athanassopoulos, A., and Curram, S. (1996). A comparison of data envelopment analysis and artificial neural networks as tools for assessing the efficiency of decision-making units. *Journal of the Operational Research Society*, Vol. 47, pp.1000-1016.
- [6] Ayadi, F., Adebayo, A. and Omolehinwa, E. (1998). Bank performance measurement in a developing economy: An application of data envelopment analysis. *Managerial Finance*, Vol. 24, No. 7, pp. 5-16.
- [7] Banker, R., Charnes, A., and Cooper, W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, Vol.30, No. 9, pp. 1078-1092.
- [8] Banker, R. D., Conrad, R. F. and Strauss, R. P. (1986). A comparative application of DEA and Translog method: An illustrative study of Hospital production. *Management Science*, Vol. 32, No. 1, pp. 30-44.
- [9] Barros, C. P., Nektario, M. and Assaf, A. (2010). Innovative applications of O.R. Efficiency in the Greek insurance industry. *European Journal of Operational Research*, Vol. 205, No. 2, pp.431-436.
- [10] Berger, A. N. and Humphrey, D. B. (1997). Efficiency of Financial Institutions: International Survey and Directions for Future Research. *European journal of operational research*, Vol. 98, No. 2, pp.175-212.
- [11] Bhattacharya, A., Lovell, C., and Sahay, P. (1997). The impact of liberalization on the productive efficiency of Indian commercial banks. *European Journal of Operational Research*, Vol. 98, No. 2, pp. 332-345.
- [12] Cagil, G. and Karabay, M. E. (2010). An Implementation towards the evaluation of financial performance in Turkish Insurance sector at global crisis scale. *International Journal of Economics and Finance Studies*, Vol. 2, No 1, pp. 45-54.
- [13] Charnes, A., Cooper, W., and Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, Vol. 2, No. 6, pp. 429-444.
- [14] Charnes, A., Cooper, W. W. and Rhodes, E. (1979) Short communication: measuring the efficiency of decision making units. *European Journal of Operational Research*, Vol. 3, No. 4, pp.339.
- [15] Charnes, A., Cooper, W. W. and Rhodes, E. (1981). Evaluating program and managerial efficiency: An application of data envelopment analysis to program follow through. *Management Science*, Vol. 27, No. 6, pp. 668-697.
- [16] Chen, T., and Yeh, T. (1998). A study of efficiency evaluation in Taiwan's banks. *International Journal of Service Industry Management*, Vol. 9, No. 5, pp.402-415.
- [17] Das, A. (1997a) Technical, Allocative and Scale Efficiency of Public Sector Banks in India. *Reserve*

- Bank of India Occasional Papers*, Vol. 18, Nos. 2 and 3, pp. 279-301.
- [18] Das, A. (1997b). Measurement of Productivity Efficiency and Its Decomposition in Indian Banking Firms. *Asian Economic Review*, Vol. 39, No. 2, pp. 422-439.
- [19] Das, A. (2000). Efficiency of Public Sector Banks: An Application of Data Envelopment Analysis Model. *Prajnan: Journal of Social and Management Sciences*, Vol. 28, No. 2, pp. 119-31.
- [20] Drake, L., and Howcroft, B. (1999). Measuring the relative efficiency of the selling function: An application of data envelopment analysis to UK bank branches. *Journal of Financial Services Marketing*, Vol. 3, 297–315.
- [21] Drake, L., and Howcroft, B.(2002). An insight into the size efficiency of a UK bank branch network. *Managerial Finance*, Vol. 28, No. 9, pp.24–36.
- [22] Ennsfellner, K. C., Lewis, D. and Anderson, R. I. (2004). Production efficiency in the Australian insurance. *The Journal of Risk and Insurance*, Vol. 71, No.1, pp. 135–159.
- [23] Farrell, M. J. (1957). The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society*, Series A, General, Vol. 120, No. 3, pp. 253-81.
- [24] Favero, C., and Papi, L.(1995). Technical efficiency and scale efficiency in the Italian banking sector: A nonparametric approach. *Applied Economics*, Vol. 27, No. 4, pp.385–395.
- [25] Fukuyama, H. (1993). Technical efficiency and scale efficiency of Japanese commercial banks: A nonparametric approach. *Applied Economics*, Vol. 25, No. 8, pp.1101–1112.
- [26] Giokas, D. (1991). Bank branches operating efficiency: A comparative application of DEA and loglinear model. *Omega*, Vol.19, No. 6, pp.549–557.
- [27] Golany, B. & Storbeck, J. (1999). A data envelopment analysis of the operational efficiency of bank branches. *Interfaces*, 29, 14–26.
- [28] Ho, C., and Zhu, D. (2004). Performance measurement of Taiwan’s commercial banks. International. *Journal of Productivity and Performance Management*, Vol. 53, No. 5, pp.425–434.
- [29] Howland, M., and Rowse, J. (2006). Measuring bank branch efficiency using data envelopment analysis: Managerial and implementation issues. *INFOR*, Vol. 44, No. 1, pp.49–63.
- [30] Leighter, E. J. and Lovell, C. A. K. (1998). The Impact of Financial Liberalization on the Performance of Thai Banks. *Journal of Economics and Business*, Vol. 50, No. 2, pp. 115-31.
- [31] Manandhar, R. and Tang, C.(2002). The evaluation of bank branch performance using data envelopment analysis: A framework. *Journal of High Technology Management Research*, Vol. 13, No. 1, pp.1–17.
- [32] Mostafa, M. M., (2009). Modeling the efficiency of top Arab banks: A DEA–neural network approach, *Expert Systems with Applications*, Vol. 36, No. 1, pp.309–320.
- [33] Mukherjee, A., Nath, P., and Pal, M. (2002). Performance benchmarking and strategic homogeneity of Indian banks. *International Journal of Bank Marketing*, Vol. 20, No. 3, pp.122–139.
- [34] Noulas A G and Katkar K W (1996), "Technical and Scale Efficiency in the Indian Banking Sector", *International Journal of Development Banking*, Vol. 14, No. 2, pp. 19-27.
- [35] Oral, M., and Yolalan, R. (1990). An empirical study on measuring operating efficiency and profitability of bank branches. *European Journal of Operational Research*, Vol. 46, No. 3, pp.282–294.
- [36] Parkan, C. (1987). Measuring the efficiency of service operations: An application to bank branches. *Engineering Costs and Production Economics*, Vol. 12, No. 1, pp.237–242.
- [37] Rangarajan, C., and Mampilly, P. (1972), Economies of scale in Indian banking, *Technical Studies for Banking Commission Report*, Reserve Bank of India, Bombay, 244-268.
- [38] Resti, A. (1997). Evaluating the cost efficiency of the Italian banking system: What can be learned from the joint application of parametric and nonparametric techniques. *Journal of Banking and Finance*, Vol. 21, No. 2, pp. 221–250.
- [39] Roth, A. V. and Jackson, W. E. (1995). Strategic determinants of service quality and performance: evidence from banking industry. *Management Science*, Vol. 41, No. 11, pp.1720–1733.
- [40] Saha, A, and Ravishankar, T. S. (2000). Rating of Indian commercial Banks: A DEA Approach, *European Journal of Operational Research*, Vol. 124, No. 1, pp. 187-203.
- [41] Sakar, B. (2006). A study on efficiency and productivity of Turkish banks in Istanbul Stock Exchange using Malmquist DEA. *Journal of American Academy of Business*, Vol. 8, No. 2, pp.145–155.
- [42] Schaffnit, C., Rosen, D., and Paradi, J. (1997). Best practice analysis of bank branches: An application of DEA in a large Canadian bank. *European Journal of Operational Research*, Vol. 98, No. 2, pp.269–289.
- [43] Seiford, L., and Zhu, J. (1999). Profitability and marketability of the top 55 US commercial banks. *Management Science*, Vol. 45, No. 9, pp.1270–1288.
- [44] Shanmugam, K. R. and Lakshmansamy, T. (2001). Production Frontier and Efficiency Measures: An Analysis of the Banking Sector in India. *Asian-African Journal of Economics and Econometrics*, Vol. 1, No. 2, pp. 211-228.
- [45] Sherman, H., and Gold, F. (1985). Bank branch operating efficiency: Evaluation with data envelopment analysis. *Journal of Banking and Finance*, Vol. 9, No. 2, pp. 297–315.
- [46] Sherman, H., and Ladino, G. (1995). Managing bank productivity using data envelopment analysis (DEA). *Interfaces*, Vol. 25, No. 2, pp. 60-73.

- [47] Simar, L. and Wilson, P.W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of Econometrics*, Vol. 136, No. 1, pp. 31–64.
- [48] Sooden, M. and Bali M (2004). Profitability in the PSBs in India in the Pre and Post Reform Period. *Indian Management Studies Journal*, Vol. 8, No. 2, pp. 69-91.
- [49] Srivastava, R. M. (2006). Indian Commercial Banks on Path Towards Competitive Efficiency. *Vinimaya*, Vol. XXVII, No. 3, pp. 5-12.
- [50] Subrahmanyam, G. (1993), "Productivity growth in India's public sector banks: 1970-89", *Journal of Quantitative Economics*, Vol. 9, No. 2, pp. 209-223.
- [51] Swami, S. B. and Subrahmanyam, G. (1994). Comparative Performance of Public Sector Banks in India. *Prajnan*, Vol. XXII, No. 2, pp. 185-94.
- [52] Tyagarajan, M. (1975), "Expansion of commercial banking. An assessment", *Economic and Political Weekly* 10, 1819-1824.
- [53] Uppal, R. K. (2006). The Survival of Public Sector Banks in the Post LPG Era. *Journal of Commerce and Trade*. Vol. I, No. 1, pp. 68-75.
- [54] Vassiloglou, M., and Giokas, D. (1990). A study of the relative efficiency of bank branches: An application of data envelopment analysis. *Journal of the Operational Research Society*, Vol. 41, 591–599.
- [55] Wu, D., Yang, Z., and Liang, L. (2006). Using DEA–neural network approach to evaluate branch efficiency of a large Canadian bank. *Expert Systems with Applications*, Vol. 31, No. 1, pp.108–115.
- [56] Yildirim, C. (2002). Evolution of banking efficiency within an unstable macroeconomic environment: The case of Turkish commercial banks. *Applied Economics*, Vol. 34, No. 18, pp. 2289–2301.
- [57] Zaim, O. (1995), The Effect of Financial Liberalization on the Efficiency of Turkish Commercial Banks, *Applied Financial Economics*, Vol. 5, No. 4, pp. 257-264.
- [58] Zenios, C., Zenios, S., and Agathocleous, K., and Soteriou, A. (1999). Benchmarks of the efficiency of bank branches. *Interfaces*, Vol. 29, no. 3, pp. 37–51.
- [59] Zhu, J. and Sherman, D. H. (2006). Benchmarking with Quality-adjusted DEA (Q-DEA) to seek Lower-Cost High-Quality Service: Evidence from U.S. Bank Application. *Annual Operations Research*, Vol.145, No. 1, pp. 301-319.

BOAM	Bank of America	SBB	State Bank of Bikaner & Jaipur
BOBK	Bank of Bahrain & Kuwait	SBH	State Bank of Hyderabad
BOCL	Bank of Ceylon	SBP	State bank of Patiala
BONS	Bank of Nova Scotia	BOB	Bank of Baroda
BOTM	Bank of Tokyo Mitsubishi	COB	Corporation Bank
BRCL	Barclays Bank	OBC	Oriental Bank of Commerce
BNPP	BNP Paribas	UNB	Union Bank of India
CHTC	China Trust Commercial Bank	BOI	Bank of India
CTBK	Citi Bank	ALB	Allahabad Bank
DBSB	DBS Bank	CAB	Canara Bank
DTSB	Deutsche Bank	INB	Indian Bank
HSBC	Hong Kong & Shanghai Banking Corporation	ANB	Andhra Bank
MSRB	Mashreq Bank	BOM	Bank of Maharashtra
MZCB	Mizuho Corporate Bank	CBI	Central Bank of India
OMIB	Oman International Bank	DEB	Dena Bank
SOCG	Societe Generale	IOB	Indian Overseas Bank
JPCB	JP Morgan Chase Bank	PSB	Punjab & Sind Bank
KRTB	Krung Thai Bank	PNB	Punjab National Bank
STCB	Standard Chartered Bank	SYB	Syndicate Bank
SONB	Sonali Bank	UCO	UCO Bank
SBMT	State Bank of Mauritius	UBI	United Bank of India
		VJB	Vijaya Bank
<b>CODE</b>	<b>DOMESTIC BANKS [Private banks]</b>	<b>CODE</b>	<b>DOMESTIC BANKS [Private banks]</b>
BOR	Bank of Rajasthan	KTB	Karnataka Bank
FDB	Federal Bank	KVB	Karur Vysya Bank
HDB	HDFC Bank	LVB	Lakshmi Vilas Bank
ICB	ICICI Bank	SIB	South Indian Bank
ING	ING Vysya Bank	TMB	Tamilnadu Mercantile Bank
JKB	Jammu & Kashmir Bank	AXB	AXIS BANK (UTI Bank)

#### Appendix 1

<b>CODE</b>	<b>FOREIGN BANKS</b>	<b>CODE</b>	<b>DOMESTIC BANKS [PSBs]</b>
RBSL	Royal Bank of Scotland N.V. (ABN AMRO Bank)	SBI	State Bank of Indore
ADCB	Abu Dhabi Commercial Bank	SBT	State Bank of Travancore
ARBB	Arab Bangladesh Bank	SBM	State Bank of Mysore