MEASUREMENT OF EFFICIENCY OF BANKS IN INDIA

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ECONOMICS

By

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To God And My Parents.

DECLARATION

I hereby declare that the work embodied in this dissertation entitled ***"Measurement of Efficiency of Banks in India"*** **carried out under the** supervision of Prof. B. Kamaiah and Dr. B. Nagarjuna is an original work of mine and has not been submitted for the award of any research degree or diploma of any university.

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Certificate

This is to certify that **Mr. V. Vijay Kumar** has carried out the research embodied in the present dissertation entitled ***"Measurement of Efficiency of Banks in India"*** for the full period prescribed under M.Phil ordinances of the University of Hyderabad.

This dissertation is an independent work and does not constitute part of any material submitted for any research degree or diploma here or elsewhere.

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CHAPTER-I

INTRODUCTION

1.1 INTRODUCTION:

The performance of banks has become a major concern of planners and policy makers in India, since the gains of real sector economy depend on how efficiently the financial sector performs the function of financial intermediation (Rangarajan. 1997). Efficiency operation of banks has become an important issue in India. In the financial market, banks still play a predominant role. In order to compete with non-bank financial institutions, banks should increase their levels of efficiency. Recently, a number of initiatives (inventions and innovations) have been taken to increase efficiency of the banks, such as introducing Technology. ATM. Telex-Banking. Internet Banking etc.. As product innovations and financial deregulation take place, competitive pressures rise and force bank to operate more efficiently.

Banking efficiency is also related to macro economic environment, such as monetary policy, structure of interest rates, capital/deposit mobilization, credit policy and bull and bear market conditions. These policies and conditions influence the entire economy, banks and their efficiency.

Basically Indian banks are efficiently inefficient. In the Indian banking sector, till eighties, the banks were operated in a highly regulated, protective and stressed environment. It is due to the impact of interest rate regime, direct credit control system, monetary policy and lack of technology. Hence banking sector

was not internationally competitive till then. In order to raise the standards of the banks internationally, a number of committees were appointed by RBI. Among them. Narasimham committee I (1991), Narasimham Committee II (1998) and Verma Committee (1999) were influential in improving international standards, and led to banking sector reforms, globally flexible to its deregulation, norms and conditions etc.. the above said committees have basically identified the causes for the weak banks and guidelines have been given to improve their efficiency.

In order to measure efficiency many would face problems such as methodological aspects, choosing parameters for the measure efficiency of the units/banks, using appropriate data, implementing recommendations of the formed committees and various studies on banking efficiency and so.

In the earlier studies, there are a number of limitations. Those studies do not consider many aspects, such as. implications and recommendations of their earlier studies and no study was tried earlier. To evaluate fill the gaps being situated in earlier studies, the present study is having its own importance. In this study we discussed many issues such as a) reviewing the earlier studies, committees recommendations, b) The impact of foreign bank entry after 1998 WTO regulation act. c) Methodological issues i.e.. prominent methods used recently for measuring efficiency of banks, and d) considering to choose method of appropriate variables to find out efficiency in banks etc..

1.2 BANKING IN INDIA:

Prior to 1969 the Indian banking system was dominated by private ownership. A large part of the banking system was brought under direct

government control in 1969. Nationalization of banks brought with it a shift in focus towards optimizing social benefit and spatial coverage of banking services with commercial viability only as a sustenance factor.

Presently. Public Sector Banks (PSBs) account for more than 78 percent of total banking industry assets. and saddled with Non-Performing Assets (NPAs). falling revenues from traditional sources. lack of modern technology. excessive manpower. and excessive governmental equity etc.. To attain competitiveness in the financial market. the PSBs have to concentrate on above aspects.

The private banks however cannot match great reach. great size and access to low cost of deposit etc.. of the public sector banks. Therefore to combat with PSBs. they have consolidating **themselves** through mergers and acquisitions route and they are moving ahead with traditional banking business model by way of their absolute innovation and service.

Private Sector Banks have pioneered internet banking. telex-banking. anywhere banking. and mobile banking. debit cards. Automatic Teller Machines (ATMs) and combined various other services and integrated them into the mainstream banking arena. while the PSBs are still grappling. In following India's commitment to the World Trade Organization (WTO) agreement in respect of the services sector. foreign banks. including both new and the existing ones. have been permitted to open up to 12 branches a year with effect from 1998-99 as against the earlier stipulation of 8 branches.

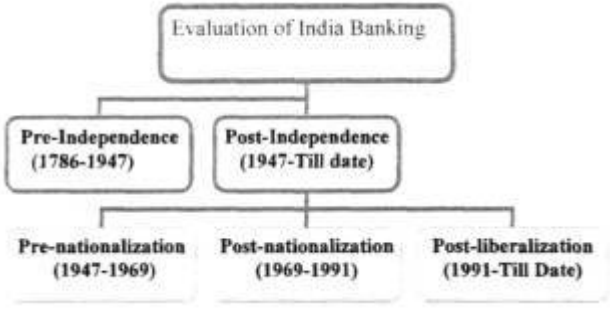
In India, banks have been allowed to provide fee-based insurance services without risk participation invest in an insurance company for providing infrastructure and services support and set up of a separate joint-venture insurance company with risk participation. Meanwhile the financial and corporate sector slowdown has led to an expansion of banks focusing on the retail segment.

1.2.1 HISTORY OF COMMERCIAL BANKING IN INDIA:

In India, the evaluation of modern banking system has been structured as follows:

Table 1.1

History of Banks in India



In the beginning of modern banking in India was made by the British in the seventeenth century. The agency houses used to perform the banking business as an adjunct to their main business. Later, in early nineteenth century, three presidency banks were set up namely, the Bank of Bengal (1806). the Bank of Bombay (1840) and the Bank of Madras (1843). Stagnant economic conditions.

falling prices and high rate of bank failures were responsible for the slow rate of growth of banking till the beginning of the twentieth century.

During the 20th century, the progress of banking was faster. In 1920. the Imperial Bank of India was set up with the merging of three presidency banks. The Reserve Bank of India (RBI) was established in 1935 as the central bank of the **country.** In 1949. the banking regulation act was passed and the RBI was nationalized and acquired extensive regulatory powers over the commercial banks.

In 1950. the Indian banking system comprised of the Reserve Bank of India, the Imperial Bank of India. Co-operative banks. Exchange banks and Indian joint stock banks. According to the amount paid up capital and reserves held by them. Indian joint banks were divided into four classes *i.e.* A. B. C and D. Later on the banks were divided into two categories of scheduled and non-scheduled banks.

In 1955. on the recommendations of the Rural Credit Survey Committee, the Imperial Bank of India was converted into the State Bank of India (SBI) and it was nationalized in 1959. In 1959. the State Bank of India (Associate Banks) Act was passed and a SBI group was created with the nationalization of eight regional banks.

The nationalization of fourteen commercial banks in 1969 was a turning point in the history of commercial banks in India. In July 1969. 14 commercial banks in the private sector, each having deposits worth Rs. 50 Crs and above were nationalized. In nationalized banks, the Government of India is a major shareholder. There was a merger of two nationalized banks in 1993 so the number

of nationalized banks has been increased to 19. These 19 nationalized banks and the 8 banks in the SBI group together are known as the public sector banks. The banking system has developed well over the years in terms of geographical coverage, deposit mobilization and credit expansion, but. it is still underdeveloped with regard to technology.

The early 1990s, guided by the recommendations of the committee on financial **system** headed by Narasimham, reforms of the banking sector in terms of deregulation and liberalization were initiated. But the second half of the previous decade saw an increased awareness of the dangers associated with inadequate regulation and supervision of banks. Therefore, banks will have to reap economies of scale in order to cut costs, raise **profitability** and bring in more transparency in their operations as move towards international best practices.

Commercial banks are the oldest and the most prominent financial intermediaries in India. Commercial banks have to work within the constraints of social goals and public ownership, and also have to maintain a proper balance between profitability and liquidity. In the financial structure of every modern economy, the commercial banks occupy a unique position and they are primarily deal with money and credit. Their major task of banks is to mobilize savings of the **community** in the form of a variety of deposits and to give loans and advances to borrowers for various purposes.

The concept of efficiency of a commercial bank is connected with diverse aspects of its operations, as its financial soundness, its profitability or its customer service. Operational efficiency in a service industry like banking has a wide

connotation. This connotation is considerably enlarged where banks are required to assume responsibilities in serving social as well as economic objectives (Angadi. 1983), and the improving efficiency has been increased substantially for the survival and sustained viability of commercial banks.

1.3 SOME MEASUREMENT ISSUES RELATED TO EFFICIENCY OF BANKS IN INDIA:

For improvement of banking sector efficiency, the RBI has constituted committees from time to time. Luther committee (1977) examined the productivity, efficiency and profitability of nationalized banks for the period 1969 to 1975 on the basis of a selected set of efficiency indicators. As a part of financial sector reforms. Indian banking is currently undergoing changes with an accent on flexibility, transparency, efficiency and profitability of the system. The approach to financial sector reforms was laid out in the report of the committee on financial system, which prescribed prudential accounting norms at par with the practices prevalent in the international banking area.

The PEP committee (1977) proposed a system of assessment of relative performance of banks on four major aspects, viz. productivity, social objectives (spatial), social objects (sectoral) and profitability. The committee had also proposed 19 indicators. Similar indicators were also used by the Finance Ministry during 1985-86 to rate the performance of banks on a relative basis.

While addressing the efficiency issues in commercial banks. Sukhmoy Chakravarty Committee (1985) observed that. "The concept of operational

efficiency of a bank in India is associated with such diverse aspects of its operations as cost effectiveness, profitability, customer services, priority sector lending, mobilization of deposits and deployment of credit in the rural and backward regions and so on. Operational efficiency in Indian banking has thus attained a wider connotation. **Precisely** for this reason. a generally acceptable definition of the concept and selection of appropriate indicators are beset with difficulties. Nevertheless. improvement in productivity in all aspects of banking operations has to be pursued by banks as an important management objective as it vitally affects the efficiency of the monetary system".

It is pertinent to note at this point that some of the performance parameters in Indian banking context have been highlighted in the 1983 by the Pendharkar Working Group (1982-83). The report stated: "… there is a need for evolving a system of evaluation and rating of bank"s performance on the basis of certain parameters. To make the **system** of supervision more purposeful and action-oriented. the broad parameters could be (i) quality of advances. (ii) management of cash and investment portfolios. (iii) management of funds. (iv) capital adequacy. (v) profitability. (vi) internal control and administration. (vii) compliance with the socio-economic objectives by the offices in India".

Ahluwalia (1985) has pointed out that in the context of service sector in India one needs to look at the broader concept of total factor productivity. which is used to explain not merely the (productive) efficiency of labour or capital but also the way the management combines these and other factors to enhance the output of the unit. The productive efficiency in this approach is measured as the ratio of

weighted output by weighted input, with weights assigned to various inputs and outputs on a heuristic basis. In this paper we use the `frontier model' approach to measure bank efficiency, wherein the weights are determined using optimality considerations.

Since the early 1990s. the Government of India has implemented many banking sector reforms. These reforms include i) lowering of Cash Reserve Ratio (CRR). ii) lowering the Statutory Liquidity Ratio (SLR). iii) a gradual deregulation of interest rates on deposits and lending. and **iv)** introduce the prudential norms in line with the international standards and the like. A system of flexible exchange rates on current account has been adopted. These and similar other policy initiates indicate the desire to make Indian banking more competitive by establishing a level playing field among the three group of banks.

The committee on the financial system. appointed by the Government of India in 1991. identified direct investment and credit programs as the two main sources of declining efficiency, productivity and profitability among commercial banks.

The Padmanabhan Working Group (1991) in its report to the Reserve Bank of India has commended the CAEL (Capital Adequacy. Asset Quality. Efficiency. Liquidity) model. However. CAEL rating is essentially an indicator of the financial condition of a bank at a particular point in time. rather than of its performance efficiency. Also. only a few of the financial ratios used in this methodology reflect productive efficiency, in terms of output/input relationships. This approach as such

does not give a composite picture of (productive) efficiency that reflects the multiple input-output situations prevalent in the banking context.

The Narasimham committee (1991) in its reports has given some recommendations. These led to banking reforms. The recommendations were basically aimed at ensuring the safety and soundness of financial institutions and at the same time at making the banking system strong, efficient, functionally diverse and **competitive.**

The Narasimham Committee (1998) has given the prudential norms for capital adequacy and income recognition, asset classification and provisioning were further tightened to bring these on par with international standards, and recommended CAMELS (Capital Adequacy. Asset quality. Management. Earnings. Liquidity and Systems) model. The adoption of CAMELS rating mechanism has facilitated inclusion **of** an additional parameter S symbolizing 'Systems' for the purpose of supervision by regulators. In view of the technical problems in measuring management **efficiency,** quantitative studies of bank efficiency have generally assumed that the managerial factor is implicitly reflected in the other four factors.

The Verma Committee (1999). in their extensive study they have suggested the efficiency measures. These parameters include capital adequacy ratio, coverage ratio, return on assets, net interest margin (spread), operative profits to average working funds, cost to income, and staff cost to net interest income plus other income. The committee found, weaknesses and strongnesses of the banks based on the study of above seven financial performance parameters, and found that no banks were fulfilled all parameters.

1.4 THE PRESENT STUDY:

It may be noted that the existing studies on banking efficiency have taken into account productivity, profitability and financial management etc.. and did not consider management of non performing assets and other relevant factors which are mainly contribute to the banking sector and its efficiency. Further, the existing studies covered only either public or private bank systems. The present study is different from the existing studies in two ways **namely,**

- The coverage of aspects for measuring efficiency includes NPA and other measures.
- The study covers public, private and foreign banks

In **the** present study, we follow the Narasimham committee (1998) recommendations and its new model for efficiency in the banking sector i.e.. CAMELS, where C- Capital Adequacy. A- Asset Quality. M- Management. E - Earnings. L- Liquidity, and S - Systems, and also followed Verma Committee (1999) recommendations.

And in this study, we have used a new method namely, the data envelopment analysis (DEA) for measuring efficiency of 93 (includes public, private and foreign) banks. The study emphasizes on the many challenges in the banking industry, namely i) Structure of the Financial System, ii) Capital Adequacy, iii) Treatment of weak banks, iv) Non Performing Assets (NPAs) and v) Potential conflicts as owner and supervisor etc.. and profitability, productivity and financial management also measured.

1.5 OBJECTIVES OF THE STUDY:

In the light of this background, the specific objective of the present study is:

i. To evaluate the efficiency of banks in India and to find out the relative efficiencies of various groups of banks namely, public, private and foreign sector banks in India

1.6 DATA:

The data used in the present study have been obtained from secondary sources. Sources of the data as follows:

i. Indian Banks Association Bulletins. 1999-2003 and various monthly bulletins

ii. Various Issues of Report on Trend and Progress on Banks in India published by Reserve Bank of India

Here, we have taken different factors like productivity, profitability: financial management and asset quality for which 20 different types of ratios have been calculated using the data from the above sources.

1.7 ORGANIZATION OF STUDY :

The remainder of this dissertation is organized as follows. Chapter II reviews the literature concerning banking efficiency in India and out side of India. Chapter III presents the methodology adopted in this study. Chapter IV provides results and discussion and the last Chapter gives findings and concluding remarks of the study.

CHAPTER II

REVIEW OF LITERATURE

2.1 INTRODUCTION:

Though the issue productive efficiency has been of interest since the days of Adam Smith. a rigorous approach to the measurement of efficiency of production can be said to have originated with the work of Koopmans (1951) and Debreu (1951). In the later years, this area has received considerable attention. Both theoretical as well as empirical works have appeared in the literature on productive **efficiency.** The subject of measuring banking efficiency has also been **extensively** studied. It is not possible to attempt to review all the studies on banking efficiency. As a background to the present study, however. an attempt is made in this chapter to present brief review of select works.

Traditionally, banking efficiency has been measured through ratio analysis as

$$\textbf{Efficiency} = \sum outputs\ j \sum inputs$$

Apart from descriptive methods and regression analysis used for the measure **of** efficiency, methods like Index numbers approach, composite index number approach using principal component analysis have been used in India from 1978. In banking sector. various technological methodologies have been used. They are:

1. Taxonomical method
2. Sequential decomposition analysis

3. Multivariate analysis
4. Translog function etc.,

The above said methodologies have been used to measure different banking performances like factor **productivity,** inter-bank difference. efficiency of benchmarks and targets. to know the impact of management efficiency on output performance of banks. and also the impact of partial liberalization during mid eighties.

The above said methodologies found that operational efficiency is at a more disaggregate level in terms of homogenous groups and seems more realistic in banking operations. In the period of pre-liberalizations banking operations are not uniform. There are wide disparities in the productivity of rural. urban and metropolitan banks and in the inter-banking productivity. After 1985. with the implementation of Data Envelopment Analysis (DEA) they came up with a drastic change in the measurement of efficiency. For example. it is used to measure scale. scope. technical and allocative efficiency which are present in banking efficiency and also the reason for they being inefficient.

To bring about positive changes in Indian banking sector DEA has been used to find out the reasons for productive. financial management and productivity inefficiency and their impact as a whole on the banking sector. Keeping it apart. taking into consideration certain factors like deposits mobilization. capital mobilization. return on assets and return on equity. profit per employee. business per employee and capital adequacy ratio and management of non-banking performing assets etc.. utilized to know which ownership of the banks are efficient

i.e., public, private and foreign banks. The studies are not only confined to find the efficiencies among the banks but also include suggestions to improve the efficiency. Most of the studies concluded that public sector banks are more efficient than private sector banks and foreign banks of which foreign sector banks are efficient compared to private sector banks.

2.2. REVIEW OF STUDIES IN INDIA:

Initially in Indian banking sector the efficiency was measured through composite Index analysis by Divitia and Venkatachalam (1978), Subramanyam (1985), Das *et.al* (1994) and Hansda (1995). In their study Divitia and Venkatachalam (1978), have attempted to measure bank efficiency based on certain indicators. Suitably represent the various aspects of banks performance for the period 1969-76 in India. They have used two methods for the analysis, namely a) simplistic method of ranking and b) ranking based on factor analysis technique. They found the assessment of operational efficiency at a more disaggregated level and in terms of homogeneous groups seems more realistic and meaningful than evolving an efficiency measure at the overall or composite level.

To measure Total Factor Productivity (TFP) by using index number approach, seperability and neutral technology, Subramanyam (1985), addressed some of the conceptual issues and their growth accounting implications. In the process Divisia index was shown to be preferable over Laspayers index, and this paper ends on a note of caution to the users of this approach.

To examine whether any change has taken place in the efficiency of banking industry with regard to productivity, profitability and financial

management, Das and Sarkar (1994), extended their analysis of efficiency measurement of banking industry by correcting some of the shortcomings of other studies in the area of coverage, methodology adopted to composite index analysis. Their study became a special branch of multivariate analysis and principal component analysis, in which they have utilized 15 indicators for the year 1994-95. They found that among private Indian banks. the nature of operation varied considerably and inter-bank differences were wider than the public sector banks.

For judging the relative performance of 28 public sector banks during the period of post-liberalization from 1991-92 to 1993-94, a composite index had been constructed by Hansda (1995). He considered 25 indicators under five categories by adopting principal component analysis, and found that in the pre-liberalization phase, the banks used to function in a more or less uniform or regulatory regime. However, the significant variation has been observed in their performance for the year 1991-92, which suggested that organizations culture and quality management had a significant sharing on the relative performance of banks.

For measuring inter bank efficiency/performance measurement, indicators like profitability, productivity, growth have been used. Angadi (1983). Karkal (1983), Subramanyam (1986), Subramanyam and Swamy (1994 a). Subramanyam and Swamy (1994 b), Kumar *et al* (1994). and Das (1999) were the main contributors.

To examine the aspect of commercial banks efficiency, scope of its instruments and the relationship between operating costs and inputs are chosen for the period 1974-1980. Angadi (1983). in his study, employed considerably simple

method used to measure variations in efficiency at different levels of output and also applicable to branch-level operations. In this study efficiency was measured in terms of Degree of responsiveness of operative cost and its influence on profitability of the banking. He found that, an individual bank could employ this technique to assess the efficiency of a branch and to maintain certain level of profitability.

Karkal (1983) measured the performance of Public Sector Banks regarding its achievement of profitability for the period 1976-1978. The study concluded that the public sector banks in rural areas are more profitable when compared to the urban and metropolitan branches. Further, in the case of newly opened branches, regardless of their location the chance of reporting losses in the initial stages seem to be very high.

There are methodological issues certain in the measurement and comparison of productivity levels in commercial banks at the aggregate level. Subramanyam (1986). attempted to show that the four conventional measures of productivity could be successfully adopted to do the job. It was emphasized that, while inter-bank productivity levels may differ sharply, because of a) differences in the speed of implementation of policy directives with administration flexibility. b) differences in the potentialities of the lead bank schemes adopted in each bank. c) differences in the potentiality of the regions, d) differences in attitudes of people they serve, and e) practical responsiveness of the bank to the situations.

Subramanyam and Swamy (1994 a), studied the inter-bank differences in the performance of public sector banks in India by using taxonomic method. It has

been found that many banks indicate wide disparities in their measure of performance, especially with differential weighing of individual indicators of business activity. No bank has shown a measure of performance close to the ideal performance of the respective group of banks. Almost every bank has never attained ever 50% of efficiency in period (1971-73 and 1987-89).

For investigating the impact of management efficiency on output performance of banks and also to account for output differences and input levels between bank groups in terms of neutral and non-neutral technological parameters. Subramanyam and Swamy (1994 b). adopted taxonomic method through simple regression for the period (1974-76 and 1984-86), it was found that production efficiency differences between the firms arise not only from technological improvements but also from competence.

Bhaumik *et al* (1991) argued that private ownership of firms leads to better performance. It has been argued that competition and hard budget constraints can induce state owned firms to operate efficiently. In India banking sector reforms were initiated in 1992-93. to entry of other firms through deregulation, which helped in better firm performance. For the period 1995-96 to 2000-01. the study suggested that ownership was no longer a significant determinant of the performance. Induced by competition, public sector banks were able to eliminate the performance/efficiency gap that existed between them and domestic private and foreign banks.

To observe the profitability of public sector banks during 1992-98. Das (1999) used sequential decomposition model. He was found that a reduction in the

burden of raising working funds in the post-reform period due to a gradual shift away from the traditional banking, a distinct risk aversion indicated by the preference for investment over advances in bank portfolios and increased competition reflected in convergence in bank-wise performance. The above studies have utilized composite index approach, principal composite analysis approach, multivariate analysis approach, taxonomic approach, translog approach, sequential decomposition etc.. to evaluate efficiency. But the various approaches could not yield satisfactory results.

From the year 1985, the Data Envelopment Analysis (DEA) had been used for measuring banking efficiency. For the first time Sherman and Gold (1985) introduced DEA to banking, as a measurement of operating efficiency of different banks, whose technique provides insights beyond those available from accounting ratios analysis. DEA. a mathematical programming technique, provides useful insights in locating inefficient units by explicitly considering different services provided and the resources used. Bank managements find that the DEA analysis provides useful insights that are not possible from other techniques; it focuses on ways to improve **productivity.** The findings of the study suggested that DEA is beneficial, and complements other techniques for improving bank/branch efficiency.

After 1985. DEA has encompassed several aspects of the banking efficiency. These includes bank branch **efficiency,** productive efficiency, frontier efficiency, cost operating efficiency, efficiency in a situation of uncertainty, efficiency in terms of bank regulator agencies, efficiency levels of the size of the banks; Issues such as foreign bank entry, additional staff hiring, issue of service

level of efficiency with bank performance and productivity of benchmarking, issue of relative efficiency with effects of credit union mergers. The relative competitiveness of the banking industry, performance of target setting procedure, productivity growth with Malmquist indices etc., have also been measured by utilizing DEA.

There are a few studies. which have used the DEA technique. For the banking sector in India. Those are Noulas and Katkar (1996). Das (2000). Saha and Sankar (2000). Kumar and Verma (2002-03) and Battacharya *et al* (1997 b). Shanmugam and Laxshmanswamy (2001). Mukerjee *et al* (2002). Sathye (2003). Tapan and Sinha (2004). Mohan and Ray (2004).

To analyze scale and technical efficiency of public sector banks in India. Noulas and Katkar (1996). adopted DEA and used cross-sectional data of 19 public sector banks for the year 1993. It has been observed that overall technical inefficiency was approximately 3.75% of which 1.5% due to pure technical inefficiency and 2.25% due to scale inefficiency. Also. a majority of the public sector banks were found to be operating under increasing returns to scale.

In the commercial banking sector. Battacharya *et al* (1997b) examined the impact of partial liberalization during mid-eighties on the productive efficiency of different categories of banks in India using DEA. The study reviewed 70 commercial banks for the period 1986-1991. and found that public sector banks had the highest efficiency followed by foreign banks; private banks were found to be least efficient. They also found a temporal improvement in the performance of

foreign banks, virtually no trend in the performance of private banks and a temporal decline in the performance of public sector banks.

To estimate and compare various frontier efficiency measure of public sector banks in India. Das (2000) used DEA. He observed that during 1998. public sector banks had the scope of producing 1.23 times as much output from the same inputs. The inefficiency of public sector banks stems from both technical and allocative efficiency components i.e. the inefficiency was due to underutilization or wasting of inputs as well as the incorrect choice of input combination in terms of prevailing prices. The findings clearly stressed that public sector banks were less efficient in dealing with the distribution of mobilized funds among competing demands: and the study suggested that public sector banks have to concentrate on business with the existing branches.

Saha and Sankar (2000) rated 25 public sector banks using DEA. Their study confined to the period 1991-92 to 1994-95. It has been observed that barring few exceptions. The public sector banks have in general improved their efficiency score over the study period. Union Bank of India. UCO Bank. Syndicate Bank and Central Bank of India were found to be at a lower end of the relative efficiency scale. Also. Corporation Bank, Oriental Bank of Commerce. SBI. Canara Bank. SBH. Bank of Baroda and Dena Bank were found to be consistently efficiency bankers.

To measure efficiency and assess the robustness of the efficiency measures using the data on domestic banks in India for the year 1999. Shanmugam and Laxshmanswamy (2001). used three approaches namely. non-parametric approach. stochastic frontier approach and random co-efficient approach. It has

been found that overall mean technical efficiency ranges between 52-80% in different approaches. There is a high rank correlation among efficiency values computed in different approaches had observed. The estimated results indicated that the deposit is the dominant factor in determining the output of the banks in all the models.

To explore technical efficiency and benchmark of the performance of 68 commercial banks. Mukherjee *et al* (2002) used DEA for the period 1996-99. They found that in India public sector banks are more efficient than both private and foreign banks. Also, the performance of public sector banks improved during the study period. Besides these, publicly owned banks were rated uniformly in terms of self-appraisal as well as peer-group appraisal.

To measure the productive efficiency of banks in India. Sathye (2003) adopted the DEA technique. In this paper, two different modes have been constructed to show how efficiency score vary with change in inputs and outputs. The efficiency scores, for three groups of banks i.e.. public, private and foreign banks are measured. The study showed that the mean efficiency score of Indian banks compares well with world mean efficiency score and efficiency of private sector commercial banks as a groups is. paradoxically lower that of public sector banks and foreign banks in India. The study recommended that the existing policy of reducing Non-performing Assets and rationalization of staff and branches may continue to obtain efficiency gains and make the Indian banks internationally competitive, which is a declared object of the Government of India.

Kumar and Verma (2002-03), had given the extent of technical efficiency benchmarks and targets for Indian public sector banks using DEA model. It has been observed that during 2001, the overall level of technical inefficiency in Indian public sector bank industry was around 17%. It has the implication that public sector banks had the scope of producing 1.21 times as much output from the same inputs. Also. banks affiliated with SBI groups outperformed the nationalized banks in terms of resource use efficiency. Besides. this. large banks are more efficient than small and medium banks in utilizing the critical inputs in their production process. The sensitivity analysis suggested that none of the frontier banks are extreme and efficiency results are quite robust.

The worst performance on efficient frontier was recorded by the United Bank of India. which was closely followed by Indian Bank and Indian Overseas Bank. From target setting exercise. it has been observed that on an average. approximately 52% physical capital. 22% staff. 21% loanable funds could be theoretically reduced if all the inefficient banks operate at the same level as the best practice banks. In an attempt to explore the relationship between efficiency and profitability using 'efficiency-profitability matrix* it has been observed that about 63% of public sector banks have the potential for profitability increase through efficiency improvements. The banking sector reforms were basically aimed at ensuring the safety and soundness of financial institutions and at the same time at making the banking system strong, efficient, functionally diverse and competitive.

To find out how individual efficiency of banks operate in a different states with a different variables correlate between different states for the years 1998-99 to

2001-2002, Tapan and Sinha (2004) took 29 state-wise distributed commercial banks. They employed DEA with Malmquist for studying total factor productivity change over a panel of 1999 to 2002. They found a high correlation between efficiency of operating in the some states and banks are high correlate with population density.

To measure the comparative performance among commercial banks using physical quantities of inputs and outputs to compare revenue maximization efficiency of banks during 1992-2000: Mohan and Ray (2004). employed the DEA. They showed that public sector banks performed significantly better than the private banks but no differently with foreign banks.

23 REVIEW OF STUDIES OUTSIDE INDIA:

In addition to the above studies. we also reviewed some selected foreign studies. These studies will help us to understand various consequences and its impact in banking industry and also useful for comparison of efficiency levels between the nations: it is also useful to identify the effects of the influence of different reforms adopted in the banking industry.

Rangan *et al* (1988) used DEA to measure the technical efficiency of US Banks. Results indicated that the banks could have produced the same level of output with only 70% of the inputs actually used. In addition. most of this inefficiency is due to pure technical inefficiency rather than scale inefficiency. Finally, regression analysis indicated that the technical efficiency of the banks is positively related to size, negatively related to product diversity, and not at all related to the extent to which branch banking is allowed.

To measure the operating efficiencies of a set of 20 bank branches of major Turkish commercial banks offering relatively homogeneous products in a multi-market business environment, Oral and Yolalan (1990) has employed DEA method. The results of the study indicated that the kind of approach is not only complementary to traditionally used financial ratios but also useful bank management a tool in reallocating resources between the branches in order to achieve higher efficiencies. It has also been observed that the service-efficiency of bank branches were also the most profitable ones and this study suggested that the existence of a relationship between service-efficiency and profitability will improve operating efficiencies.

For the comparison regarding to the operational efficiency of individual branches of a bank group Giokas (1991) adopted two different methods namely. DEA and log-linear model, and examined whether operations in the bank branches were conducted in regions of increasing, constant or decreasing returns to scale. The DEA results suggest that increasing, constant or decreasing returns to scale may be observed in different regions of the production function, where as the log-linear model suggested that increasing returns to scale are in operation.

To examine large sample of banks of all sized productivity changes in the US banking during 1984-1993. Wheelock *et al* (1994) used distance function estimates to compute Malmquist indices of productivity changes, which they decompose into indices of changes in efficiency and changes in technology. They found that banks on an average with assets exceeding $300m became more productive: while those with $300 m of assets became less productive. In most

years, banks in all size ranges experienced technical progress, but on an average, taking into consideration the productivity, especially small banks experienced decline in technical progress.

To compare technical efficiency of US banks measures derived from a model of constraints. Mester (1995) used DEA. This study was based on the single cost function model. and separate cost functions model: the distributions of the one sided error terms on which technical inefficiency measures based on wider for a single cost functions and the ranking of districts by the level of technical inefficiency differ in size. geographic size and population of the distinct. They found that the data rejected in the single cost function model and suggested it is important to studying technical inefficiency to account for differences across the markets in which banks are operating more generally. technical inefficiency has to considered. by construction. a residual. it will be particularly sensitive to emissions in the basic model.

Significant questions have been raised regarding the performance /efficiency of the commercial banks in the late 1980s. Miller and Noulas (1994. 96) calculated the relative technical efficiency for 201 large banks from 1984 to 1990. They found that relative technical efficiency on an average had been just over 5% for all the banks. Large banks and more profitable banks have more technical efficiency. At the same time. however. larger banks are more likely to operate under deceasing returns to scale. In addition. market power does not significantly affect efficiency. Finally, holding bank size and profitability constant. banks in the mid-east (north-east) are having significantly higher pure technical efficiency in the later half of the 1980s.

Berg *et al* (1997), emphasized on the relative competitiveness of the banking industries in three Nordic countries, by applying DEA to productivity on the national and the pooled data sets. This analysis produced a detailed account of how well banks from different countries and different sizes may be prepared to meet the more intense competition of a European banking market.

Berger *et al* (1997) reviewed 130 studies that apply frontier efficiency analysis to financial institutions in 21 countries. The primary goal of the study is to summarize and critically review empirical estimates of financial institution efficiency and to attempt to arrive at a consensus view. And the secondary goal is to address the implications of efficiency results for financial institutions in the areas of Government policy, research and managerial performance. They found that the various efficiency methods do not necessarily yield consistent results. They suggested that some of those methods might be improved to bring about findings that are more consistent. accurate and useful.

Research on banks efficiency has been done in two separate streams: Econometric studies and DEA, Resti (1997) used the two branches of literature on a common panel of 270 Italian banks. The study suggested as follows i.e.. a) efficiency scores shows a high variance. b) the banking system is split in two. between northern and southern banks; c) there is a direct relationship between productive efficiency and asset quality, and d) the efficiency of Italian banks did not increase over the period 1988-1992.

To evaluate the relative cost and profit efficiencies of a panel of six Singapore banks during the period 1992-96. Sing Fat and Guan Hua Lim (1998)

employed DEA. The average profit efficiency (83%) was found to be significantly lower than average cost efficiency (95%). The mean profit efficiency is, however, higher than the average banks in the US (64%) and Spain (72%). Regression study was done using the modified efficiency scores. They found that percentage changes in the prices of the bank shares reflect percentage changes in profit rather than cost efficiencies (correlation co-efficient of 0.82 versus 0.32): it opens up a new window for understanding share price fluctuations and it was to expect the shareholders desire dividends. which are paid out of profits and not income.

To examine the performance of the target setting procedure employed by a large financial institution in Spain and to evaluate the operating performance of its branches. Lovell and Pastor (1998), began by evaluating the ability of the branches to achieve the set target. They found that the list of target could be substantially reduced without significant loss or distortion of information to bank management, and the performance of branches on the basis of a reduced set of influential targets.

To investigate whether the productive efficiency of European banking system has improved and converged towards a common European banks during the period 1993 and 1997. following the process of EU legislative harmonization; And also examine the determinants of European bank efficiency. Casu and Molyneux (1998) employed DEA. Tobit regression model approach and to overcome the dependency problems a bootstrapping technique is applied. Overall. the results suggest that since EU's single market programme there has been a small improvement in bank efficiency levels. although there is litter evidence to suggest that these have converged. Efficiency differences across European banking markets appear to be mainly determined by country specific factors.

To find out operating efficiencies, employee productivity, profit performance and average relative efficiency for Australian trading banks from 1986 to 1995, Avkiran (1999) adopted DEA. Changes in banks market share of deposits was explored as a means of determining the extent to which efficiency gains are passed on to the public. Evidence from the merger cases studied, supports the reports of others that acquiring banks are more efficient that target banks. However, the acquiring bank does not always maintain its pre-merger efficiently. He found that, decision-makers ought to be more reliable in promoting mergers as a means to enjoying efficiency gains. There is mixed evidence on the extent to which the benefits of efficiency gains are passed on to the public.

Parken and Ming-Lu Wu (1999) discussed an issue of hired additional staff in the Hong Kong international investment bank. In anticipation of increased business activity that eventually did not quite materialize and management was concerned about the effect of that decision on the banks overall performance profile. This paper summarized a study that carried out to address two related questions using only the available data at the time: a) What is the direction of the overall performance and trend, and b) how serious is the impact of the international costs of hiring additional staff been on the banks overall performance? The discussion focused on the construction of the banks performance profile using a new performance measurement methods called operational competitiveness rating analysis of DEA rating and profit scores to show the validity support among their approaches as well as under scope their differences.

To examine the relative efficiency of 16 Australian credit union mergers for the period June 1992- June 1997, Garden and Ralston (1999) adopted multiple regression and applied to examine the impact of credit union mergers on technical efficiency and allocative efficiency. The DEA frontier approach is used to provide measures of technical efficiency and allocative efficiency. The results provide statistical evidence that on average, credit union mergers do not result in an increase in technical efficiency or allocative efficiency relative to other credit unions.

To explore productivity growth in a group of 201 large US banks over the initial post-deregulation period i.e. 1984-1990, Mukherjee *et al* (2001). adopted DEA with Malmquist indices and isolated the contributions of technical change, technical efficiency change, and scale change to productivity growth. They found overall productivity growth at the rate of about 4.5% per year on average, but productivity declined by 7.61% in 1984 -1985 and 0.33% 1998-99. In their analysis, second-stage panel regression reveals that larger asset size and specification of product mix associate with higher productivity growth while higher equity to assets associates with lower productivity growth.

Sathye (2001). investigated the technical efficiency in Australian banks, where DEA has been used to arrive at the efficiency scores. Banks in this sample were found to have low levels of overall efficiency compared with the banks in the European countries and in the US. The results indicated, as a source of overall inefficiency, the technical component was more important than the allocative component. Thus, the inefficiency in Australian banks can be attributed to wasting of inputs rather than choosing the incorrect input combinations. Domestic banks

were found to be more efficient than foreign banks. This study has important implications such as guiding the government policy regarding deregulation of mergers. Since this study pinpoints the sources of inefficiency, it would also help banks with strategic planning.

Manandhar and Tang (2001. 2002) emphasized the existing studies on efficiency of bank branches using a DEA technique. They have not considered intangible aspects associated with resources inputs in the branches. The intangible aspects of resource inputs in a branch characterize the effectiveness of service delivery system in supporting efficient and quality service delivery to external customers. In order to fill this gap. this paper developed a framework for incorporating this aspect into a DEA framework in the form of internal service quality. The study suggested that the simultaneous benchmarking of the performance of bank branches along multiple dimensions of performance considered are internal service quality, operating efficiency and profitability.

To estimate the indicators of commercial bank efficiency in a wide range of transition countries. Griogrian and Manole (2002). employed DEA. and argued that to fully asses the efficiency of commercial bank operations it is necessary to model various types of functions performed by banks. and control the inputs necessary provide a certain level of utility to owners and depositors. This paper also explains the differences in efficiency between financial institutions and countries by a variety of macro economic. prudential, and institutional variables. This paper is able to provide some answers to a range of fundamental questions of the optimal architecture of a banking system.

Jahanshahloo *et al* (2003) discussed many applications of DEA. The existing models are designed to obtain a single efficiency measure. In many situations, the units under considerations may perform different functions or can be separated into different components. In this paper, bank branch efficiency is analyzed using data from 31 bank branches in Iran. They found that various efficiency methods do not necessarily yield consistent results and suggest some ways that these methods might be improved about and that they are more consistent, accurate, and useful.

Maggi and Rossi (2003) investigated the efficiency of European and US commercial banks. Scale, scope and X-efficiency are derived from three cost functions: They are Fourier flexible form, Translog and Box-Cox. This allows checking the stability and the robustness of the evidence across the different specifications. Their results over the period 1995-98 show that the overall average cost curve is relatively flat with some evidence of scale efficiency gains. More fuzzling are the results on the presence of scope economies.

To investigate the impact of foreign bank entry on banking efficiency in Australia during the post-deregulation period 1988-2001, Sturm and Williams (2004) employed DEA. Malmquist indices and Stochastic frontier analysis. They found foreign banks are more efficient than domestic banks, which however did not result in superior profits. Major Australian banks have used size as a barrier to new entrants. Furthermore, bank efficiency has increased post-deregulation period and the competition resulting form diversity in bank types was important to prompt efficiency improvements. Finally, the recession of the early 1990s resulted in a distinct shift in the process of efficiency changes.

2.4. CONCLUDING REMARKS:

From the above all studies, DEA has been used for various issues in the banking efficiency. Earlier scale and scope efficiency were only examined but with the implementation of DEA. one can examine other differences also. such as bank branch efficiency, productive efficiency, frontier efficiency, scale. scope and technical efficiency, cost efficiency in situation of uncertainty, efficiency in terms of bank regulator agencies, operating efficiency, efficiency levels of larger and smaller sizes of the banks. The issue of foreign bank entry, issue of additional staff hiring, performance and productivity of benchmarking, issue of service level of efficiency with bank performance, relative cost and profit efficiency, relative efficiency with effects of credit union mergers can also be studied. Productivity growth with Malmquist indices. relative competitiveness in banking industry, performance of target setting procedure employed by a large financial institutions. managements and performance of efficiency between financial institutions in transition countries have been found.

In the above studies there are a number of limitations in the methodology aspect and measurement issues. which are not fully satisfied i.e.. Basically in Indian studies, they were not looking in the deeper stage of banks efficiency in terms of using the new techniques, different committee's considerable recommendations and they were not include present banking position such that studies would raise many questions regarding to efficiency of banks in India.

INDIAN STUDIES AT A GLANCE					
S.No	**Authors**	**Focus of the Study**	**Technique Used**	**Sample Period and Data**	**Conclusions and Findings**
I	Divitia and Venkatachalam (1978)	Banks Performance	Composite Index. Factor Analysis	1969-76	The assessment **of** operational **efficiency** at a more disaggregate level and in terms **of** homogeneous groups, seems more realistic and meaningful
2	Subramanyam	Measuring total Factor Productivity	Index number approx	-	Divisia index is shown to be preferable over Laspayers index for the **measuring** total factor productivity.
3	Angadi(1983)	Commercial Banks efficiency and scope for its instrument	Degree of Responsiveness of operative cost	TFC,TA, Deposits. Credit 1974-1980	This method can be used for an individual bank to assess the efficiency of branch and to maintain a certain level of profitability.
4	Karkal (1983)	Profitability of the Public Sector Banks	-	1979-1978	The number of rural branches increased in profit making in case of PSBs it was declined for urban and metropolitan branches.
5	Subramanyam	Comparison to inter- bank productivity in commercial bank	**Four** measures i.e, Kendrik, Solow, Domar and Tinbegan	-	Inter-bank productivit\ levels may differ **sharply,** because **of** 1. **differences** in the speed of implementation **of** polices 2. differences in the potentialities **of** the led bank schemes 3. differences in the potential of **the** regions. 4. differences **in** the attitudes of **the** people they serve 5. practical situation of involvement.

6	Subramanyam and Swamy (1994a)	Inter-bank differences in the performance of PSBs	**Taxonomic** Method	1971-72 and 1987-89	Many banks indicates wide disparities in their measure of performance and on bank has shown close to ideal performance of the respective groups of banks.
7	Das and Sarkar (1994)	Efficiency of the Banking	Composite Index	Productivity, Profitability, FM for the years 1994-95	Among Indian Private banks, the nature **of** operation and inter bank differences wider than the PSBs
8	Subramanyam and Swamy (1994 b)	Impact **of** management efficiency output performance of banks	Taxonomic Method through simple regression	1974-76 and 84-86	Production efficiency differences between firms arise not only from technological improvement but also form competence.
9	Hansda (1995)	Relative performance of public sector banks for the period of post-liberalization	Composite Index and Principal Component Analysis	LP, BP. I M. Profitability and Growth for the period 1991-92 to 1993-94	In pre-liberalization phase, the banking functions are more or less uniform. However, the significant change observed in 1991-92 and suggested that organizations, culture and **quality** management has a significant sharing on the relative performance of banks
10	Das (1999)	Inter-bank variability of profitability among PSBs	Sequential Decomposition model	1992-98	A reduction in the burden of raiseing working funds due to gradual shift among from traditional banking, distinct risk aversion in the post-reform period.
11	Noulas and Katkar (1996)	Technical and scale efficiency of 18 PSBs	DEA	1993	PSBs are operating under increasing returns to scale i.e. overall technical efficiency was 3.75% of which 1.5% due to pure technical inefficiency and 2.25% due to scale **inefficiency.**

12	Das (2000)	Compare various frontier efficiency of PSBs	DEA	Deposits, borrowing, staff, spread, commission, exchange and brokerage	During 1998, PSBs had the scope of producing 1.23 times of much output from the same inputs. The inefficiency was due to underutilization of wasting of inputs as well as incorrect choice of combination in terms of prevailing prices
13	Satan and Ravisankar (2000)	Efficiency ratings to the PSBs	DEA	1991-92 to 1994-95	The PSBs have improved their **efficiency** score over the study period. Corporation bank. Oriental bank. Bank of Commerce. SB1. Canara bank. **SBH,** Bank of Baroda and Dena bank were found to be consistently efficiency banks.
14	Kumar and Verma (2002-03)	**Technical** benchmarks and targets for PSBs	DEA. CCR Model	Capital. Labour, loanable funds. Spread. Interest income	It has the implication that PSBs had the scope of producing 1.21 times as much output from the same inputs. Larger banks are more efficient than small or medium banks in their production in utilizes the critical inputs in their production process.
15	Battacharya *et al(1997)*	Impact of partial liberalization during mid-eighties on the productive efficiency of different categories of commercial banks	DEA	1986-91	PSBs had the highest efficiency followed by foreign banks, private banks were found to be least efficient.
16	Shanmugam *et al* (2001)	Efficiency and assess the robustness of domestic banks	DEA. SFA and Random coefficient approach	1991, output. Deposit, borrowings and **labour**	Overall mean technical efficiency ranges between 52-58% in different approaches. **They** found that, deposit is the dominating the output of the banks in all models.

17	Mukherjee *el al* (2002)	Technical efficiency and benchmark of the performance of 68 commercial banks	DEA	1996-99	PSBs are more efficient than both private and foreign banks. PSBs were rated uniformly in terms of self-appraisal as well as peer-group appraisal.
18	**Sathye (2003)**	Productive efficiency of banks in India	DI A	-	PSBs are more efficient, followed by foreign banks, private banks listed in least efficiency banks. He recommended, the existing policy of reducing NPAs and rationalization of staff and branches may be contributed to obtain efficiency gains and make the **Indian** banks internationally competitive.
19	Tapan and Sinha (2004)	Investigate how states offers efficiency of banks and other variables	DEA with Malmquist indices	1998-99 to 2001-2002	There is a high correlation between **efficiency** of operation in the same states i.e. the states which top in one year is also tends to be at the top in other years. It has been found that banks are high correlate with population density.
20	Mohan and Ray (2004)	Comparison performance of banks among commercial banks	DEA	1992-2000	PSBs performed significantly better than the private, but no difficulty in foreign banks.

FOREIGN STUDIES AT A GLANCE:

S.No	Author	Country of study	Focus of the Study	Method Adopted	Sample period and Data	Concluding results and findings
1	Sherman and Gold (1985)	USA (14)	Using DEA for banking	DEA	Labour, expenses, space. Number of transactions	Successfully used DEA in banking for measure efficiency
2	Parkan(l987)	Canada (35)	To measure efficiency	DEA	Labour, expenses, space, rent, terminals. Number of transactions. customer response, error corrections	
3	Oral and Yolalan (1990)	Turkey (20)	To measure operating efficiency relating homogeneous products in multi market products	DEA	Labour, terminals, number of accounts, credit applications . Number of transactions	**They** found that service-efficient bank branches are most profitable units
4	Vassiloglou and Giokas (1990)	Greece (20)	To measure efficiency	DEA	Labour, supplies ,floor space, computer terminals. Number of transactions	
5	Giokas (1991)	Greece (17)	Comparison regarding the operational efficiency of individual branches regarding to CRS or DRS	DEA	Labour, expenses, rent, Number of transactions	IRS, CRS or DRS may be observed through DEA. where as loglinear model suggested IRS to its operation
6	Berg *et al* (1993)	Three Nordic Countries	Relative competitiveness of the banking industry	DEA		Banks from different countries and different sizes may be prepared to meet the more intense competition of a European banking market.
7	Miller and Noulas (1994, 96)	USA	Significant difficulties in 1980's in banking performance & Efficiency	DEA	1984-990	Market Power does not significantly affect **efficiency.**

8	Sherman and Ladino (1995)	USA (33)		DEA	Labour, expenses, rent, Number of transactions	More variables has need to measure efficiency.
9	Berger *et al* (1997)	21 countries	Critical review on empirical estimates of financial institutions	Various frontier analysis		Various efficiency methods do not necessarily yield consistent results. DEA is find significantly more efficient.
0	Schaffnit *et al* (1997)	Canada	Performance of branch level banking	DI \ \R (Assurance Region)	Personal Salary. Cost	-
1	Andera Resti (!997)	Italy	Efficiency of banks on a common panel of 270 banks	DEA, Econometric studies	1988-92	i) **efficiency** score show a high variance, ii) their is direct relationship between productive **efficiency** and asset quality. iii) the **efficiency of** Italian banks **did not** increase **efficiency** levels.
3	Bhattacharya, Lovell and Saha\ (1997)	India (74)		DI A	Interest expense, operating expense, Advances, deposits, investments	
4	SchafTnit. Rosen and Paradi(1997)	Canada (291)		DEA	Personnel (Teller. typing, accounting, supervision, credit) . Transactions(counter transactions, counter sales, security transactions, deposit sales, commercial loan sales, personal loan sales). Maintenance(commercial and personal loan accounts)	

15	Sing Fat *et al (1998)*	Singapore	Relative cost and profit efficiency	DEA	1992-96	Average profit efficiency was found to be significantly lower than the cost efficiency. The percentage changes in prices of the bank share reflect percentage change in profit rather than cost efficiency.
16	Lovell and Paster (1998)	Spain	The performance of the target setting procedure. Operating performance of bank branches	DEA		Targets can be substantially reduced without significant loss or distortion of information to bank management: and performance of branches on the basis of a reduced set of influential targets.
17	Casu and Molyneux (1998)	Europe	Investigate whether the productive efficiency of European banking has improved and coverage towards a common European frontier	DEA. Tobit regression model	1993 and 1997	EU's single market programme, there has been a small improvement in bank **efficiency** levels: and found that, there is a little evidence that EU banks are converged.
18	Avikiran (1999)	Australia Trading banks	Efficiency of banks	DI A	Operating efficiency, employee productivity, profit 1986-1995	Decision makers ought to be more reliable **in** prompting mergers as a means of enjoying efficiency gains.
19	Garden and Ralston (1999)	Australia	The impact of credit union mergers on X-efficiency and allocative efficiency	DEA	June 1992 - June 1997	Credit Union mergers do not result in an increase in X-efficiency or allocative efficiency related to other credit unions

20	Manandhar and Tang (2001, 02)		Reviewing the existing studies on efficiency evaluation of bank branches	DEA	Service quality, operating **efficiency,** profitability	Simultaneous bench marking of the performance of bank branches along multiple dimensions.
21	Mukherjee *et al* (2001)	USA Commercial Banks	Productivity growth for a group of201 large banks	DEA, Malmquist Index	1984-1990	Overall productivity declined over the period, larger asset size and specification of product mix associate with higher **productivity,** growth wile higher equity to assets associates **with** lower productivity growth.
22	Sathye (2001)	Australia	X-Efficiency	DEA		**The** banking varying X-efficiency rather than al locative **efficiency.** Domestic banks were found more **efficiency** than foreign banks
23	Griogorian and Manole (2002)	Transition Countries	To finding out indicators **of** commercial banks efficiency	DI A		Prudential tightening on the efficiency *of* banks, policy actions, i) tighter minimum CAR are associated with stronger **revenue,** ii) relatively lack of foreign exchange exposure limits doing better than those in countries with tighter policies and iii) single borrower related limits **do** not **effect** bank performance **in** a statistical manner.

24	Jahanshahloo *et al* (2003)	Iran	Bank branch efficiency in various existing studies	DEA		Various efficiency methods do not necessarily yield consistent.
25	Maggiad Rossi (2003)	European and USA banks	Scale and Scope economic indicators, X-efficiency	Fourier flexible form. Translog, Box-Cox	1995-98	Overall average cost curve is relative flat with some evidence of scale efficiency gains.
26	Strum and Williams (2004)	Australia	Impact of foreign bank entry on banking efficiency in period of post-deregulation	Malmquist index, stochastic frontier analysis	1988-2001	Foreign banks are more **efficient** than domestic banks, which however did not result in superior profits. Bank **efficiency** has increased n post-deregulation and the competition results from **diversity** in bank types was **important to** prompt efficiency improvements.

CHAPTER III

METHODOLOGY

3.1. INTRODUCTION

The efficiency is a broader concept it involves optimally choosing the levels, and mixes of inputs and/or outputs. The economic efficiency implies both technical efficiency and allocative efficiency.

The overall bank efficiency can be decomposed into scale efficiency, scope efficiency, pure technical efficiency, and allocative efficiency. The bank has the scale efficiency when it operates in the range of constant returns to scale (CRS). Scope efficiency occurs when the bank operates in different diversified locations when the bank maximizes the output from the given level of input, pure technical efficiency occurs. Technical efficiency is the major method that to measure efficiency. Allocative efficiency happens when the bank choosing revenue maximizing mixes of outputs. Theoretically, a bank is fully efficient if it produces the output level and mix that maximize profits and minimize possible costs. However, in reality, most banks are not fully efficient.

There are many sources of inefficiency in the banking industry. Most of the sources for inefficiencies are caused by inappropriate operation i.e, excessive use of labour in branch offices, and financial inefficiency, such that excessive interest paid for funds.

Technical efficiency is defined a ratio of minimum costs that could be have expended to produce a given output bundle to the actual costs expended.

Technical efficiency variance between 0-100% and it includes both technical and allocative inefficiency, or errors that result in general oversees of inputs and allocative inefficiency, or in choosing on input mix that is consistent with relative prices.

There are four types of technical efficiency estimations based on different assumptions. They are Data Envelopment Analysis (DEA). Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA), and Distribution Free Approach (DFA). They differ from one another on the basis of the arbitrary assumptions used to disentangle efficiency differences form random error using a single observation for each firm. WE can separate those approaches into two categories based on the parametric and non-parametric.

- Parametric approaches - SFA. TFA. DFA
- Non-parametric approaches - DEA

For the present study, we have using non-parametric approach i.e.. Data Envelopment Analysis for measuring efficiency of banks in India.

3.2 THEORETICAL UNDERPINNINGS:

Consider a firm employing n inputs $x = (x_1 \ldots\ldots\ldots\ldots x_n)^1$ available at fixed prices $w \equiv (w_1 \ldots\ldots\ldots w_n) > 0$. TO produce a single output y it can be sold at fixed price p>0. Transformation effect of inputs into output is characterized by the production function f(x), which shows the maximum output obtainable from various **input** vectors. Under certain regularity conditions an equivalent representation of efficient production technology is provided by the cost function

$c(y,w) \equiv \min_x \{w^1 x/f(x) > y, x > 0\}$, which shows the minimum expenditure required to produce output y at input prices w. A vector of cost minimizing input demand can be obtained by means of Shepherd's lemma as $x(y,w) = v_w c(y,w)$, provided $\bar{v}_w c(y,w)$ exists. Under certain regularity conditions a third equivalent representation of efficient production technology is provided by the profit function $\pi(p.\ w) \bullet \max_{y,x} [py - w'x/f(x) \geq y.\ x > 0, y > 0\}$, which shows the maximum profit available at output price **p** and input prices w. A vector of profit maximizing output supply and input demands can be obtained by means of Hotelling's lemma as $y(p,w) = \pi_p(p,w)x(p,w) = -\bar{v}_w \pi(p,w)$, provided the derivates exist.

Let us now suppose that the firm is observed at production plan (y°. x°). Such a plan is said to be technically efficient if $y^o = f(x^o)$, and technically inefficient if $y^o < f(x^o)$, here an assumption that $y'' > f(x'')$ to be impossible.

One measure of the technical efficiency of this plan is provided by the ratio $0 \leq y''/f(x^0) \leq 1$. Technical inefficiency is due to excessive input usage, which is costly, and so $w'x^o \geq c(y^o, w)$. Since cost is not minimized, profit is not maximized, and so $py'' - w'x^o < \pi(p,w)$.

The plan (y^o, x^o) is said to be allocatively efficient if/, $(x^o)/f_j(x^o) = w_i/w_j$. and allocatively inefficient if $f_i(x^o)/f_j(x'') \neq w_i/w_j$, assuming the function to be differentiable . Allocative inefficiency results from employing **inputs in the** wrong proportions, which is costly, and so

$w'x^o \geq c(y^o, w)$. Since cost is not minimized, profit is not maximized, and so $(py^o - wx^o) \leq \pi(p, w)$.

It follows that observed expenditure $w'x^o$ coincides with minimum cost $c(y^o, w)$ if and only if. the firm is both technically and allocatively efficient. If $w'x'' > c(y^o, w)$, this difference may be due to technical inefficiency alone. Allocative inefficiency alone. or some combination of the two. It also observed that, input usage x^o coincides with cost minimizing input demand $x(y^o, w)$ if and only if, the firm is both technical and allocatively efficient. A combination of technical and Allocative inefficiency causes $x^o \geq x_i(y^o, w)$ for at least some inputs. but may cause $x^0 < x\ (y^o, w)$ for some other inputs.

A combination of technical and allocative efficiency is necessary but not sufficient for $(py^o - wx'') = \pi(p, w)$. Necessity is obvious: the combination is not sufficient because the firm could still be scale inefficient. A firm is said to be scale efficient if $p = cy(y^o, w)$. and it is said to be scale inefficient when $p \neq cy(y^o, w)$. It follows that $py'' - w'x'' = \pi(p, w)$ if and if only, the firm is technically, allocatively and scale efficient. If $py'' - M'X'' < \pi(pw)$, this combination may be due to any combination of the three types of inefficiency. It also follows, observed that output supply $\mathbf{y^o}$ and input usage u° coincide with profit maximizing output supply y(p, w) and input usage **x(p,** w) if and if only, the firm is technically, allocativelv and scale efficient.

3.3 DATA ENVELOPMENT ANALYSIS:

As Farrell (1957) originally argued, information concerning the frontier and the relative efficiency of DMUs has many policy implications. He provided definitions and a computational framework for both technical and allocative inefficiency.

Farrell's approach is non-parametric in the sense that he simply constructs the free disposal convex hull of the observed input-output ratios by linear programming techniques: this is supported by a subset of the sample with the rest of the sample points lying above it. As case with non-parametric approach, the "estimated" frontier is supported by a subset of the data and is therefore extremely sensitive to outliers.

Farrell also argued that while attempts to solve the problem usually produced careful the measurements of the multiple inputs to satisfactory overall measure of efficiency. Responding to these inadequate of separate indices of labour productivity, capital productivity etc., Farrell proposed an activity analysis approach that could more adequately deal with the problem. His measures were intended to be applicable to any produce an organization: in his words. ".....from workshop to a whole economy".

Farrell approach has been extended and applied by Farrell and Fieldhouse (1962), Seitz (1970, 71). told (1971). Afrait (1972). Dugger (1974) and Meller (1974). The principle advantage of the approach is that no functional form is imposed on the data. The principle disadvantage is that the assumption of constant returns to scale is restrictive, and its extension to non-constant returns to scale

technologies is cumbersome. A second disadvantage of the approach is that the frontier is computed from a supporting subset of observations from the sample, and is therefore particularly susceptible to extreme observations and measurement error.

To fill the gaps in the Farrell's approach. Charnes *et al* (1978) originally introduced DEA. and various researchers have developed it over throughout the years. Two basic models are CCR (Charnes. Cooper and Rhodes. 1978), BCC (Banker. Charnes and Cooper. 1984). However. there are numerous models and selection of an appropriate model depends on the nature of production technology. In general, these models differ in their orientation (input, output), disposability (strong, weak), diversification and returns to scale (CRS. IRS. DRS). types of measure (Radial measure, non-radial measure. Hyperbolic measure) etc..

The non-parametric method initiated as Data Envelopment Analysis (DEA) by Charnes. Cooper and Rhodes (1978. 91) builds on the individual firm evaluation of Farrell. and extends the emerging ratio approach to efficiency measures from a single-input/output efficiency analysis to multi-input/output situations. In contrast to preceding parametric approach. DEA does not require any assumptions about the functional form: the efficiency of a Decision Making Unit (DMU) is measured relative all other DMUs with the simple restriction that all DMUs lie on or 'below' the efficiency frontier.

DEA is a methodology directed to frontiers rather than central tendencies. Instead of trying to fit a regression plane through the center of the data, one 'flats' a piecewise linear surface to rest on top of the observations. Because of this

unique perspective, DEA proves particularly adept at uncovering relationships that remain hidden for other methodologies.

DEA is a tool for evaluating relative efficiency since it first identified units on the efficiency frontier and then compares other units. input-output relationship with those of the frontier. It allows to rank units according to their technical efficiency scores and to single out the driving forces. for inefficiencies.

DEA, a mathematical programming technique. provides useful insights in locating inefficient units by explicitly considering the mix of services provided and the resources used to provides these units. DEA is able to locate inefficient units more powerfully when the number of units in the study exceeds the number of outputs and inputs included in the data set.

Classification of the DEA efficiency measures identified the inefficient DMUs with some positive primal slacks. Sensitivity analysis of the DEA efficiency measures showed that the extreme efficient (Thamson *et.al* (1997). DEA assigns a score to each production unit **(DMU)** considered in the analysis such score indicates whether the unit is efficient or not. For inefficient units. it also identifies a hypothetical unit as the target and thus suggests improvements to their efficiency. However. for efficient units no further improvement can be indicated based on a DEA analysis. Nevertheless. it is important for management to indicate targets for poorly represented in the data set (Siwlati *ei.al (2003).*

The next section is on introduction to the foundations of the basic DEA models. Details on Charnes. Cooper and Rhodes (CCR). 1978. and Banker

Charnes, Cooper (BCC), 1984 models are provided along with a short discussion on some to the extensions of the models.

3.3.1 CHARNES, COOPER, RHODES (CCR) MODEL

Introducing the Charnes. Cooper, and Rhodes (CCR) [1978,1979,1981] ratio form of DEA.

$$\text{maximize:} \quad h_o = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}$$

$$\text{subject to:} \quad \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1; \quad j = 1, 2, \ldots, n$$

$$\frac{u_r}{\sum_{i=1}^{m} v_i x_{io}} \ge \varepsilon; \quad r = 1, \ldots, s \qquad (1)$$

$$\frac{v_i}{\sum_{i=1}^{m} v_i x_{io}} \ge \varepsilon; \quad i = 1, \ldots, m$$

$$\varepsilon > 0$$

This model is designed to evaluate the relative performance of some decision making unit (DMU). designated as DMU_0, and based on observed performance of j=1,2,.....n DMUs. A DMU is to be regarded as an entity responsible for converting inputs into outputs.

The $y_{rj}, x_{ij>0}$ in the model are constants which represent observed amounts of the r^{th} output and the i^{th} input of the j^{th} decision making unit which we shall refer to as DMU_j in a collection of $j = 1, \ldots, n$ entities which utilize these i = 1.2.....m inputs and produce these r= 1.2.....s outputs. One of the

j=1,2,. . . . .,n DMUs is singled out for evaluation, accorded the designation DMUo, and placed in the functional to be maximized in (1) while also leaving it in the constraints. It then follows that DMUo's maximum efficiency score will be $h_0 < 1$ by virtue of the constraints.

The $£ > 0$ in equation (1) represents a non-Archimedean constant which is smaller than any positive valued real number. Hence. it need not be specified explicitly. We therefore turn to other topics as follows.

The numerator in equation (1) represents a set of desired outputs and the denominator represents a collection of resources used to obtain these outputs. This ratio results in a scalar value similar to ratio forms often used in accounting and other types of analyses. The value h_0^- obtained from this ratio satisfies $0 < h_0^- < 1$ and can be interpreted as an efficiency rating in which $h_0^- = 1$ represents full efficiency and $h_0^- < 1$ means inefficiency is present. The star (*) indicates an optimal value obtained from solving the model. Furthermore. h_0^- is invariant to the units of measure used for the input and output variables.

Also, note that no weights need to be specified a priori in order to obtain the scalar **measure** of performance. The optimal values u_r, v_i may be interpreted as weights **when** solutions are available from the equation (1). But. they are determined in the solution of the model and not a priori. To emphasize differences from **more customary** (a priori) weighting approaches, the u_r, v_i values secured by solving the above problem are called ***virtual multipliers*** and interpreted in DEA so

that they yield a ***virtual output***, $Y_0 = \sum_{r=1}^{s} u_r^* y_{r0}$ (summed over $r = 1 \ldots\ldots s$), and a ***virtual input***, $X_0 = \sum_{i=1}^{m} v_i^* x_{i0}$ (summed over $i = 1 \ldots m$), which can allow us to compute the efficiency ratio $h_o = Y_o / X_0$

As can be observed from equation (1), this is the highest rating that the data allow for a DMU. No other choice of u_r and v_i^* can yield a higher h_o^* and satisfy the constraints. These constraints make this a relative evaluation with

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} = 1 \text{ ; for some j as a condition of optimality}$$

Similar efficiency evaluations can be obtained for each of the $j = 1 \ldots\ldots n$ DMUs listed in the constraints of equation (1) by according them the same treatment, i.e. positioning them in the functional as DMUo. one by one. while also leaving them in the constraints.

These efficiency ratings are more than just index numbers. which indicate ranking of DMUs based on their efficiency. The value of h_0^- has operational significance in that $1 - h_0^-$ provides an estimate of the inefficiency for each DMUo being evaluated. Carried further. as shown below. this characterization makes it possible to identify the sources and amounts of inefficiency in each input and output for every one of the DMUs being evaluated.

It should be emphasized that the orientation of DEA is generally toward relative efficiency as determined by the above optimization applied to the data. Thus, for any DMUo being evaluated, the optimization implies that the evaluation will be effected by reference to the subject of j=1.....,n. DMUs for each

$$\frac{\sum_{r=1}^{s} u_r^* y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} = 1, k \in K \qquad \text{..... (2)}$$

When the stars (*) indicate that these u_r and v_i values are optimal, and hence, make h_o maximal for DMUo. the DMU being evaluated. In addition. $k \in K$ indicated the subset of DMUs that have attained the value of unity, which is the maximum value. allowed by the constraints. Note that these $k \in K$ DMUs have attained the value of the unity with the same u_r, v_i which are best for DMUo.

Using U ,V to represent vectors with components u_r, v_i which are optimal for DMUo in equation (1), we observe that such a choice will not give $h_0^* = 1$ unless DMUo is also in the set $k \in K$. If $h_0^* < 1$, then DMUo will be characterized an inefficient relative to the set of DMUs in equation (2) which obtain 100% efficiency with these same U , V values. In other words. DMUo is rated relative to an efficient subset of DMUs in general, different efficient subsets being utilized for the wanted efficiency ratings as different DMUs are brought into the functional of equation (1) for evaluation.

TRANSFORMATION TO LINEAR PROGRAMMING FORM:

The problem in equation (1) would be computationally intractable if addressed directly. Fortunately, the theory of fractional programming, as first given in Chames and Cooper (1962) makes it possible to replace equation (1) with an equivalent linear programming. The transformation to accomplish this can be found in Charnes. Cooper and Rhodes (1978). Here they simplified the following as a transformation problem.

$$
\left.
\begin{aligned}
&Maximize: \sum_{r=1}^{s} u_r y_{r0} \\
&Subjo: \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0 \\
&\sum_{i=1}^{m} v_i x_{i0} \\
&-u_r \le -\varepsilon \\
&-v_i \le -\varepsilon
\end{aligned}
\right\} \quad \text{.....(3)}
$$

The first set of j = 1.2.....n constraints in equation (3) come from the less-than-or-equal to unity requirements in equation (1) while u_r, v $> e > 0, \forall$ r, I, come from the non-Archimedean conditions in equation (1). Also, $\sum v_i x_{io}$=1 guarantees that is possible to move from equation (3) to equation (1), as well as from equation (1) to equation (3). Finally, the theory of fractional programming as given in Charnes and Cooper (1962) insures that

$$h_0^* = \sum_{r=1}^{s} u_r^* y_{r0} \quad \text{.....(4)}$$

where the stars (*) indicate optimal values in equation (1) and equation (3) respectively.

The formulation in equation (3) provides contact with economics. This is accomplished by interpreting equation (3) so that the objective is to maximize virtual output subject to virtual input while maintaining the condition that virtual output cannot exceed virtual inputs for any DMU. As noted in Charnes *et al* (1985), it implies that the conditions for Pareto (or) Pareto-Koopmans optimality. as they are called in economics. are fulfilled since further increases in this maximal **value** can be attained only if some of the input value x_{ij} are increased or if some of the output values y_{rj} are decreased.

Since equation (3) is a linear program, it has dual which can be represented as follows:

$$\left.\begin{aligned} &\text{min}imize: \theta - \varepsilon\left[\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right] \\ &Subto: \theta x_{i0} - \sum_{j=1}^{n} x_{ij}\lambda_j - s_i^- = 0 \\ &y_{r0} = \sum_{r=1}^{n} y_{rj}\lambda_j - s_r^+ \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (5)$$

$0 < \lambda_j, s_i^-, s_r^+ \forall i, r, j$ and θ unrestricted in sign.

It is from equation (3) that the name data envelopment analysis is derived. Note mat any admissible choice of λ_j provides an upper limit for the outputs and a lower limit for the inputs of DMUo and against these limits 9 is tightened with λ_j^*, s_i^{-*}, $s_r^{+*} \geq 0$ representating optimizing choices associated with minimize $\theta = \theta^*$.

The collection of such solutions then provides an upper bound which envelopes all of the observations. and hence, leads to the name Data Envelopment Analysis.

Recalling that x_{i0}, y_{r0} are represented in the constraints as well as the functional in equation (1), it is clear that equation (5) always has at least the solution $0 = 1$, $\lambda_0 = 1$ and all other λ , $s_i^{-*}, s_r^{+} = 0$ when DMUo is the DMU under evaluation. It follows than an optimum will be attained with $0 \le \theta^* < 1$. Because equation (5) has a finite optimum, the duality theory of linear program gives as follows:

$$h_0^* = \theta^* - \varepsilon\left(\sum_{i=1}^{m} s_i^{-*} + \sum_{r=1}^{s} s_r^{+*}\right) = \sum u_r^* y_{r0} \quad \ldots\ldots\ldots (6)$$

Note that $0' = 1$ does not imply $h_0^* = 1$ unless also $s_i^{+*}, s^{-*} = 0$ V i and r. That is. all slack must also be zero in equation (6). Conversely, $s_i^{+*}, s_i^{-*} = 0$ V r and i does not imply $h_0^* = 1$ unless $0' = 1$. In other words, it is necessary to have both $0' - \backslash$ and zero slack for efficiency or. conversely, fy' = 1 implies $0' = 1$ and all slack equal to zero in an optimum solution to equation (1) in order for DMUo to be characterized as fully efficient via DEA. Therefore. $h_0^* = 1$, if and only if. DMUo is also efficient.

3.3.2 BANKER, CHARNES AND COOPER (BCC)MODEL :

Another version of DEA is in common use in BCC (1984) model. The primary difference between this model and the CCR model is the treatment of

returns to scale. The CCR model is the treatment evaluation of constant returns to scale. The BCC version is more flexible and allows variable returns to scale.

Following is the equivalent of equation (5) for the BCC formulation

$$\begin{aligned} &\text{min imize}: \theta - \varepsilon\left[\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right] \\ &\text{Subto}: 0 = \theta x_{i0} - \sum_{j=1}^{n} x_{ij}\lambda_j - s_i^- \qquad \text{.....(7)} \\ &y_{r0} = \sum_{r=1}^{s} y_{rj}\lambda_j - s_r^+ \\ &\lambda_j = 1 \end{aligned}$$

$0 < \lambda_j, s_i^-, s_r^+$, V i, r and j.

Main difference between CCR and BCC model i.e. equation (5) and equation (7) is that the *As* are now restricted to summing one. This has the effect of removing the constraint in the CCR model that DMUs must be scale efficient. Consequently, the BCC model allows variable returns to scale (VRS) and measures only technical efficiency for each DMU. That is. for a DMU to be considered as CCR efficient, it must be both scale and technical efficient. For a DMU to be considered BCC efficient, it is only need to be technically efficient.

The separate evaluation of returns to scale in the BCC model is more evident in the dual to equation (7) which we write as follows:

$$\max : \sum u_r y_{r0} - v_0$$

$$Sub\,to : \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - u_0 \le 0$$

$$\sum_{i=1}^{m} v_i x_{i0} = 1 \qquad \ldots\ldots\ldots\ldots (8)$$

$$-u_r \le -\varepsilon$$

$$-v_i \le -\varepsilon$$

In this model, the u_0^* indicates the returns to scale possibilities. An u_0^* <0 implies local increasing returns to scale. If $u_0 \approx 0$, this implies local constant returns to scale. Finally, an $u_0^* > 0$ implies local decreasing returns to scale. Note that the CCR model previously discussed simultaneously evaluates both technical and scale efficiency in the aggregate. The BCC model, however, separates the two types of inefficiencies in the envelopment model (model 7) and scale inefficiencies in the dual to (7) (model 8)-

DEA has been validating through a variety of means such as observations, simulations, and hypothetical data sets with known efficiencies and inefficiencies.

3 .3.3 DATA ENVELOPMENT MODEL EXTENSIONS:

Since the initial development of DEA by CCR in 1978, there have been several variations of the model developed in response to new and varied needs. The intent here is to discrete some of these models and what they were designed to do. We have given extensions of DEA model is as follows:

A. ADDITIVE MODEL: The concepts of the additive model were first introduced in Charnes *et al* (1985) and elaborated on in Banker *et al* (1989). The additive model formulated is as follows:

$$\begin{aligned} &miximize: \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \\ &Subto: 0 = x_{i0} - \sum_{j=1}^{n} x_{ij}\lambda_j - s_i^- \\ &y_{r0} = \sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ \\ &\sum \lambda_j = 1 \end{aligned} \quad \ldots\ldots\ldots\ldots (9)$$

$0 < \lambda_j, s_i^-, s_-^+$ V i. r and j .

The formulation corresponds to the BCC envelopment version of DEA. Another version of the additive model which corresponds to the CCR formulation model, can be created by omitting the $\sum x_j$ condition in the above equation. The difference between this additive model and BCC version is that the *0* (proportional amount of inefficiency) is dropped from the model and all inefficiencies are captured in the slack values (s_r^+ and s_i^-). Thus, the only test for efficiency is whether all slacks are zero.

A DMU, which is efficient for the BCC model, will also be efficient for the additive model and vice versa (Ann *et al, 1988).* However, when a DMU is inefficient, the sources and amounts of inefficiency may differ for the two versions of the DEA model because of the different metrics used in accomplishing the efficiency evaluation.

B. MULTIPLICATIVE MODEL: The models previously discussed (i.e., CCR, BCC and Additive) prescribed an additive combination of outputs and inputs. Charnes *et al (1983, 82)* present a multiplicative combinational method. The primary difference between this model and the other models is that the virtual outputs and virtual inputs are formed multiplicatively instead of additively. That is, the summation sign $(\sum)$ can replaced by a product sign (Π) in the above models equations. The Y and X vectors of outputs and inputs are logarithms. The result is that the frontier is piece-wise log-linear (Cobb-Douglas type) rather than piece-wise linear as is the case for the CCR. BCC and other models. Like the additive model, the multiplicative model identifies inefficiencies only through slack values and no intensity or proportional variable (i.e., θ)is involved.

c. **MEASURES OF EFFICIENCY DOMINANCE MODEL:** The CCR. BCC and other DEA model allow the comparison of an organization (not an the frontier) to a linear combination of entities that are on the frontier. In some cases. however. it may be desirable to restrict comparisons to actual organizations instead of linear combinations of organizations. As shown in Bardhan *et al* (1996), one way of doing this is to modify' the continuity assumption in the BCC and CCR models. The result is a bi-valency variant of the DEA additive model, which Bardhan *et al* refer to as a Measure of Efficiency Dominance (MED).

D. ASSURANCE REGION AND POLYHEDRAL CONE-RATIO MODELS: Charnes *et al (1990)* point out that the construction of an empirical production function may be flawed. It may inadequately represent what is actually possible, or the results can reflect efficient. input and output values that DMU margins might consider to

be outside the range of realistic possibilities. To overcome this problem, two models have been developed which restrict the value that the virtual weights may attain and thereby, limit the range of acceptable of inefficiency of beings two input units and two output units.

One approach is the Assurance Region approach which. was first presented in Thomson *et a l* (1986) and further defined in Thomson *et al* (1990). The Assurance Region (AR) model provides lower and upper bounds on the admissible values of variable. These bounds take the following form:

$$\alpha_r \le v_r / v_{r0} \le \beta_r \,, \; r = 1, \ldots\ldots\ldots, s$$

$$\delta_i \le u_i / u_{i0} \le \gamma_i \,, \; i = 1, \ldots\ldots\ldots, m$$

Here. v_{r0}, u_{i0} represent dual variables which serve to establish the upper and lower bounds represented by α_r, β_r and δ_i, γ_i for the dual variables associated with each output and input and $\alpha_{ro}, \beta_{ro}, \delta_{io}, \gamma_{io} = 1$.

Assurance Regions are a special case of Polyhedral Cone-Ratios as described in Charnes *et al* (1990). The Polyhedral Cone-Ratio variation of the DEA model also restricts the ranges of relative valuation of inputs or outputs based on the preferences of managers about the relative importance of different factors and what determines best practice. The virtual weights are controlled so as to favour desired patterns of input usage and/or output production, and thereby, make possible the use and incorporation of expert knowledge in the evaluation.

E. NON-DISCRETIONARY VARIABLE MODEL: The DEA model provides information about the extent to which an input should be decreased or an output augmented by an inefficient organization in order for it to become efficient. However, managers sometimes deal with non-discretionary variables that have values determined by forces exogenous to the organization under evaluation. In other words, the values of these inputs or outputs are beyond the control of the organizations management. Consequently, management or an analyst might want to treat these types of inputs and outputs differently in a DEA analysis of the performance of an organization because they are outside the discretionary control of the managers, and the managers can take no action to affect these inputs and outputs.

The amount of a non-discretionary, fixed input variable can be reduced can be determined but may not be meaningful because the input cannot be reduced. However, in many cases it is important to take these non-discretionary amounts into account in an evaluation of an organization.

F. CATEGORICAL VARIABLE MODEL: Banker and Morey (1986) offer an adaptation to the DEA model that permits the inclusion of variables that are categorical. This extension of DEA relaxes the need for the variables to be measured on a continuous scale and allows the incorporation of on-off or present variables in the analysis.

3.4 COMPARISON BETWEEN DEA WITH REGRESSION ANALYSIS:

In the past, regression approaches have been commonly used for measuring efficiency. Consequently, here we discuss some of the differences between

regression and DEA in order to highlight DEA's characteristics. In the following table we have discussed some conceptual issues relating to the differences between the Data Envelopment Analysis and Regression Analysis

Problem	DEA	Regression
Multiple inputs and outputs	Simple	Complex, rarely undertaken
Specification of the functional form	Not required	Required and my be incorrect
Outliers or unusual observations	Inaccurate efficiency assessment	Not as sensitive
Sample Size	Small size can be adequate	Moderate sample size required statistics become unreliable if too small, and important factors may be incorrectly omitted from the model
Explanatory factors highly collinear	Better Discrimination	Possible misleading interpretation of relationships
Explanatory factors have a low correlation	All efficiency scores tend to be close to unity	No problem
Noise, such as measurement error	Highly sensitive	Affected, but not as **severely** as in DEA
Testing, including variable selection	Sensitivity analysis is possible but complex, so is more subjective	Straightforward statistical testing.

The table illustrates that each technique has advantages and disadvantages. As such, it is difficult to recommend one technique as being superior to any other. Both statistical techniques provide straightforward procedures for testing the significance of individual variables and model assumptions, and give a clear estimate of the size of the relationship between a cost driver and the relevant cost. As such, they are useful in determining the appropriate factors to be included in a DEA model.

DEA is much more of a important technique—the exact relationship between inputs and outputs is difficult to ascertain or test. However, DEA can provide useful information in addition to the simple efficiency ranking of companies. For instance, the technique can provide answers to the following questions.

1. Which company is inefficient company A most likes?
2. How much of the overall inefficiency is caused by: technical inefficiency: allocative inefficiency: congestion of inputs: or scale inefficiency?

In general, it would seem appropriate to use several of the techniques, with the separate results used to check the robustness of the efficiency assessments. However, this may still be problematic as consistency of the results may not occurs (as indicated in the discussion above).

3.5 DEA IN BANKING INDUSTRY:

DEA was Firstly applied by Sherman and Gold (1985) for assessing the efficiency of bank branches. it is a tool for evaluating relative efficiency since it first identifies banks efficiency frontier and then compares with other banks. It allows ranks to the banks according to their technical efficiency scores and to single out driving forces for inefficiencies.

In banking industry. DEA model is preferable to econometric approach of efficient measurement because of it has a number of advantages i.e..

1. It can simultaneously analyze several inputs and outputs, which is an alternative characterizes because production in the banking industry often involves multiple inputs and outputs.

2. It does not require any assumptions about the functional form of technology, and

3. It calculates a maximal perfonnance measure for each production unit relative to all other production units in the observed population with the sole condition that each production unit lies on or below the external frontier.

3.6. USES; **MERITS** AND DEMERITS OF **DEA:**

DEA is commonly used to evaluate the efficiency of a number of producers. A typical statistical approach is characterized as a central tendency approach and it evaluates producers relative to an average producer. In contrast. DEA is an extreme point method and compares each producer with only the 'best' producer. By the way. in the DMU extreme point methods are not always the right tool for a problem, but are appropriate in certain cases.

DEA has been applying in may cases such as Heath Care. Education. Banks. Manufacturing sector. Benchmarking. Management evaluation. Fast Food restaurants and Retails stores etc..

DEA's SPECIFIC ADVANTAGES: AS earlier list of applications shows. DEA is a powerful too when used wisely. As few of characteristics that make it powerful is:

1. It is able to derive a single aggregate score. which indicates the performance status of each DMU relative to a designated group of Peers. DMUs are directly compared against a peer or combination of peers.

2. It is capable to identifying and perceived slack in input used or output produce and provide insight on possibilities for increasing output and/or conserving input in order for inefficiency DMU to become efficient.

3. DEA does not require an assumption of a functional form relating inputs and outputs. Inputs and outputs can have very different units. It can handle multiple inputs/outputs to generate a set of weights to each input/output.

4. DEA cannot support zero output values.

LIMITATIONS OF DEA: DEA has fewer limitations than other performance measurement approaches in the choice of input and output variables the efficiency measure obtained by DEA is sensitive to the combination of inputs and outputs. If inputs and outputs are properly chosen. DEA can provide crucial information Although DEA can identify performance targets with respect to reference units, it does not tell us how to achieve these targets. The limitations of DEA:

1. Since DEA is an extreme point technique, noise such as measurement error can cause significant problems.

2. DEA is a good at estimating 'relative efficiency* of a DMU but it converges very slowly to 'absolute efficiency". In other words, it can tell us how well we are doing compared to out peers but not compared since a 'theoretical maximum*.

3. Since DEA is a non-parametric technique, statistical hypothesis tests are difficult and are the focus of ongoing research.

4. Since a standard formulation of DEA creates a separate function for each DMU, large problems can be computationally intensive.

3.7. CONCLUDING REMARKS:

With providing sufficient information of banks to analyze with the DEA. it will give the useful insights about the banks efficiency levels. locate efficiency/inefficiency factors. it will set ranks to different banks through relative efficiency, it also shows the banks returns to scale which will help to investors/depositors, and it will also be useful for the measurement efficiency of banks in different categories, different variables. For the present study we have used BCC (1984) model. which has been discussed earlier.

CHAPTER-IV

EMPIRICAL ANALYSIS

4.1 INTRODUCTION:

The present study is based on data obtained from 93 scheduled commercial banks (SCBs). The banks include 27 public sector. 36 foreign and the rest 30 private banks. The study has a wider coverage than most of the earlier studies. The data used in the analysis relate to pertaining to measures of **Productivity,** Profitability and Financial Management and Asset Quality The data used in this study have been colleted from various issues of Indian Banks Associations annual reports and RBI's Reports on Progress of Banks. In this study, we find efficiency of the commercial banks during the period 1999-2000 to 2002-2003. The reference year of the study related to the financial year 1999-2000. for which we have used DEA. to calculate efficiency we have used GAMS progamme and DEA Solver package.

For measuring the efficiency in the banking sector. we consider the objectives such as a) include recommendations of newly appointed committees by RBI and various studies. b) considering the impact of entry of foreign bank in Indian financial sector after 1998 WTO relation Act and c) methodological aspects.

In the literature there are two different approaches used in banking system, namely "production approach" and "intermediation approach". There is no consensus however in respect of the inputs and outputs **to** be considered for measuring efficiency/performance.

Humphrey (1985) made a useful distinction between the two approaches and its behaviour in the banking. The production function views banks as 'producing' demand deposits. lime and saving deposits. commercial loans, real estate loans, and installment loans. using capital, labour. and materials so on. In this case. the number of accounts and loans outstanding provide the appropriate measure of bank output, and total costs include all operating costs incurred in the production approach. Where as. intermediate approach treats banks as collects of funs which are then 'intermediated' into loans and other assts. and it is concerned with the overall costs of banking and is appropriate for addressing questions concerning the economic viability of banks. Although the intermediation approach is not commonly used in empirical studies. neither approach is completely sat is fact ory. largely because deposits have both input and output characteristics. which are not easily disaggregated empirically.

Bergar *et al* (1987) concerned with competitive **viability,** and preferred the intermediation approach. Bergar and Humpary (1997) suggest that the intermediation approach is best suited for analyzing bank **level** efficiency. where as the production approach is well suited for measuring branch level efficiency. This is because. at the bank level. management will aim to reduce total cost and not just non-interest expenses. while at the branch level a larger number of customer service processing take place and bank funding and investment decision are mostly not under the control of branches. Also. in practice. availability of data flow-required by the production approach is usually exceptional. Therefore. in the present study we have considered 'intermediation approach' for measuring/choosing input and output variables of banks.

Traditionally, banks have used profitability as a basis of other measures such as productivity and quality. In the past few years, these practices have started to change towards benchmarking programs based on different indicators such as productivity, profitability, financial management, asset quality etc..

For measuring productivity, we consider different parameters such as. establishment expenses to operating expenses as inputs and business per branch. business per employee and operating profit per employee are taken as outputs.

Where. Business per branch = Total Deposits/Number of Branches

Business per employee= the amount of deposits mobilized per employee

For measuring profitability, we consider net profit to spread. establishment expense to operating expenses as inputs and Return on assets. Return on Equity. Net interest income as percentage to assets. Net profits to deposits are taken as outputs.

Where. Spread = interest earned - interest paid

RoA = Net interest margins+ Net-Interest income ratio+ operating expense ratio.

RoE = RoA*EM. EM is equity multiplier i.e. average assets/average equity.

The above all parameters have taken and calculated on the basis of ICRA studies. which leads us to asses efficiency of Indian banks.

For measuring Financial Management, we have considered spread to total advances, NPA to net advances as inputs and average yield on assets. Average yield on advances. average yield on investments and capital adequacy ratio has been taken as outputs.

Where, Yield on Assets= Interest incomeTotal assets

Yield on Advances= Interest earned on advances/total advances

Yield on Investments= Income from investment/Investments.

If the financial management performance is better. then the banks will lead towards efficiency in their management of assets. liquidity, advances. deposits, mobilization of assets and capital adequacy ratio etc..

For measuring asset quality we consider various parameters based on the Indian Banks' Association Review on the performance of banks. The parameters are Gross NPAs/ Gross Advances, Net **NPAs/Net** Advances as inputs and Gross NPAs/Total Assets. Net NPAs/Total Assets are considered as outputs.

In our study, efficiency has measured by using DEA. The details of the technique are discussed in Chapter 3, The results are presented in tables 4.1 to 4.8 and the score and rank of the respective banks are presented in Appendix-II (tables A.1 to A. 12).

From table 4.1, it is evident that public sector banks during the sample period banks arc operating between less efficient and inefficiency category. From which Corporation Bank. Oriental Bank of Commerce are operating at score and

rank unity (1). Relatively SBI and Group performance is better than the nationalized banks, from which SBI is operating efficiently.

For the profitability, all public sector banks are performing between less efficient and efficiency category except UCO Bank, United Bank of India. In this indicator. Corporation Bank. Dena Bank. Oriental Bank of Commerce, United Bank of India from nationalized and Stale Bank of Indore. State Bank of Mysore, State Bank of Patiala from State Banks Group are having score unity. And relatively State Bank of Bikaner and Jaipur. State Bank of Hyderabad. State Bank of Saurashra are also efficient.

For the financial management, all banks are operating between less efficient and efficient category. Andhra Bank. Corporation Bank. United Bank of India rank one (1) during the sample period, and State Bank of Patiala also shows the efficient in the sample period.

For the Asset Quality, most of the banks are being inefficient throughout the sample period, though a few banks have shown rank unitv in study period, i.e.. Corporation Bank. State Bank of Indore, State Bank of Mysore and State Bank of Saurashra.

From the above analysis of the public sector banks throughout the sample period, most of the banks are found in the category of less efficient i.e. [0.5, 1). From which Corporation Bank, Oriental Bank of Commerce, State Bank of Indore are found to be efficient in all categories and many nationalized banks were recorded as worst performance in the sample period.

Table 4.1

Public Sector Banks for the period 1999-2000 to 2002-2003

S.No	Name of the Bank	Productivity				Profitability				Financial Management				Asset Quality			
		1999-2000	2000-2001	2001-2002	2002-2003	1999-2000	2000-2001	2001-2002	2002 2003	1999-2000	2000 2001	2001 2002	2002 2003	1999 2000	2000 2001	2001 2002	2002-2003
1	Allahabad Bank	®	X	X	X	X	X	X		X	X	X	X	®	®	®	®
2	Andhra Bank	®	®	X	X	X	X	X	X		V	V		X	X		X
3	Bank of Baroda	X	X	X	X	X	X	X	X	X	V	X	X	®	®	®	8
4	iBank of India	®	®	®	X	X	X	X	X	√	V		√	®	X	X	X
S	iBank of Maharashtra	®		X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	(anara Bank	®	®	X	X	X	X	X	X	X	X	V	V	X	X	X	X
7	Central Bank of India	®	®	®	®	X	X	X	X	X	X	X	X	®	®	®	®
8	Corporation Bank			V	V	V		√		√		١	V				X
9	Dena Hank	S	®	X	®	√	√	V	√	X	V	X	X	X	√		X
10	Indian bank	⊗	®	®	®	√	V	X	X	√		√	X	®	X	®	®
11	Indian Overseas Bank	®	®	®	®	X	X	X	X	X	X	X	X	X	X	X	®
12	**Oriental Bank** of **Commerce**		V	V		V		V	V	V	V	X	√	√	V	X	
13	**Punjab** & Sind **Bank**	®	®	®	®	V	X	X	V	√	V	V			X	X	
14	Punjab National Bank	®	®	®	®	X	X	X	X	X	X	X	X	®	®	®	®
15	Syndicate Ban	®	®	®	®	X	X	X	X	X	√	X	X	X	X	X	X
16	I ('O Hank	®	®	®	®	®	X	X	X	X	X	X	V	®	X	X	X
17	Union Bank of India	®	®		X	X	X	X	X	V	V	X	X	®	⊗	X	X
18	United Bank of India	®	®		®	®	V	V		√				⊗	X	®	S
19	Vijaya Bank	®	®	®	®	X	X	X	X	X	X	V	X	X	X	X	X

20	State Bank of India (SBI)	X	V			X	X	X	X	X	X	X	V	®	⊗	⊗	X
21	State Bank of Bikaner & Jaipur	®	®	®	®		√		X	X	X	X	X	X	X	X	X
22	**State Bank of Hyderabad**	X	X	X	X	√	√	√	X	X	X	X	X	X	X	X	X
23	**State Bank of Indore**	X	X	X	X	√	√			X	X	X	X	√	√	√	√
24	**State Bank of Mysore**		®	®	®		V	V	√	X	X	X	X	X	√	V	√
25	State Hank of Patiala	®	®	X	X	V	√	√	√	X	√			X	X	X	V
26	State Bank of Saurashra	®	X	X	X	V	√	√	X		V	X	X	X	V	√	√
27	State Bank of Travancore	®	®	⊗	(8)	X	X	X	X		X	X		X	X	X	X

Note: 'V' indicates that the bank is efficient, i.e., I >I \ score is one
V indicates that the bank is less efficient, i.e., DEA score range is [0.5, 1)
'⊗' indicates that the bank is inefficient, i.e., DEA score less than 0.5.

Table4.2

Private Sector Banks for the period 1999-2000 to 2002-2003

S.No	Name of the Bank	Productivity				Profitability				Financial Management				Asset Quality			
		1999-2000	2000-2001	2001-2002	2002-2003	1999-2000	2000-2001	2001-2002	2002-2003	1999-2000	2000-2001	2001-2002	2002-2003	1999-2000	2000-2001	2001-2002	2002-2003
1	Bharat Overseas Bank Ltd.	⊗	⊗	⊗	⊗	√	X	X	X	X	X	X	X	⊗	⊗	⊗	⊗
2	City Union Bank Ltd	⊗	⊗	⊗	⊗	√	X	X	X	√	X	X	X	⊗	⊗	⊗	⊗
3	Development Credit Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	X	⊗	X	√	X	X	⊗	⊗	⊗	⊗
4	ING Vysya Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	X	⊗	√	X	X	X	⊗	⊗	⊗	⊗
5	Karnataka Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	X	⊗	X	X	√	X	⊗	⊗	⊗	⊗
6	Lord Krishna Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	√	√	√	X	√	√	⊗	⊗	⊗	⊗
7	The National Bank Ltd	⊗	⊗	⊗	⊗	√	⊗	X	⊗	√	√	√	√	√	√	√	√
8	SBI Comml. And Intl. Bank Ltd	√	√	√	√	√	√	⊗	⊗	√	√	√	√	⊗	⊗	⊗	⊗
9	Tamilnad Mercantile Bank Ltd	⊗	⊗	⊗	⊗	X	X	X	⊗	√	√	√	√	⊗	⊗	⊗	⊗
10	The Bank of Rajasthan Ltd	⊗	⊗	⊗	⊗	X	⊗	X	X	X	X	X	⊗	⊗	⊗	⊗	⊗
11	The Catholic Syrian Bank Ltd	⊗	⊗	⊗	⊗	√	⊗	√	√	X	X	X	X	⊗	⊗	⊗	⊗
12	The Dhanalakshmi Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	X	⊗	X	X	X	X	⊗	⊗	⊗	⊗
13	The Federal Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	X	⊗	√	X	X	X	⊗	⊗	⊗	⊗
14	The Ganesh Bank of Kurundwad Ltd	⊗	⊗	⊗	⊗	X	⊗	X	⊗	√	√	√	√	√	√	√	√
15	The Jammu & Kashmir Bank Ltd	⊗	⊗	⊗	⊗	√	√	X	√	X	√	√	X	⊗	X	X	⊗

16	The Karur Vysya Bank Ltd	⊗	⊗	⊗	⊗	√	√	√	X	√	√	X	X	⊗	⊗	⊗	⊗
17	The Lakshmi Vilas Bank Ltd	⊗	⊗	⊗	⊗	√	√	X	⊗	X	X	X	X	⊗	⊗	⊗	⊗
18	The Ratnakar Bank Ltd	⊗	⊗	⊗	⊗	√	⊗	√	√	X	X	X	X	⊗	X	X	⊗
19	The Sangli Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	X	⊗	⊗	⊗	X	X	⊗	⊗	⊗	⊗
20	The South Indian Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	X	X	X	X	X	X	⊗	⊗	⊗	⊗
21	The United Western Bank Ltd	⊗	⊗	⊗	⊗	√	⊗	X	⊗	X	X	X	X	⊗	⊗	⊗	⊗
22	Bank of Punjab Ltd	X	√	√	√	√	√	√	√	X	X	√	X	⊗	X	X	⊗
23	Centurion Bank Ltd	√	√	X	X	√	√	√	X	√	√	√	√	⊗	⊗	⊗	⊗
24	Global Trust Bank Ltd	X	X	X	X	√	√	X	√	√	√	√	√	√	X	⊗	⊗
25	HDFC Bank Ltd	⊗	√	√	X	√	√	X	√	√	√	√	X	√	√	√	X
26	ICICI Bank Ltd	⊗	X	X	√	X	X	⊗	√	√	√	√	√	X	X	⊗	⊗
27	IDBI Bank Ltd	⊗	⊗	⊗	X	√	⊗	X	√	X	√	X	√	X	⊗	X	⊗
28	Indusland Bank Ltd	√	√	√	√	√	X	X	X	X	√	X	X	⊗	⊗	⊗	⊗
29	Kotak Mahindra Bank Ltd	⊗	⊗	⊗	X	X	X	√	√	⊗	⊗	⊗	⊗	⊗	X	X	√
30	UTI Bank Ltd.	⊗	X	√	X	X	√	√	√	√	√	√	√	⊗	X	X	⊗

Note: '√' indicates that the bank is efficient, i.e., DEA score is one
X indicates that the bank is less efficient, i.e., DEA score range is [0.5, 1)
® indicates that the bank is inefficient, i.e., DEA score less than 0.5.

Table 4.3
Foreign Sector Banks in India for the period 1999-2000 to 2002-2003

S.No	Name of the Bank	Productivity				Profitability				Financial Management				Asset Quality			
		1999-2000	2000-2001	2001-2002	2002-2003	1999-2000	2000-2001	2001-2002	2002-2003	1999-2000	2000-2001	2001-2002	2002-2003	1999-2000	2000-2001	2001-2002	2002-2003
1	ABN-Amro Bank N.V	X	X	⊗	X	X	⊗	X	X	√	X	X	⊗	√	X	⊗	⊗
2	Abu Dhabii Commercial Bank Ltd	⊗	√	√	√	⊗	⊗	⊗	X	√	X	√	X	⊗	⊗	⊗	⊗
3	American Express Bank Ltd	⊗	X	X	⊗	⊗	X	X	√	X	⊗	⊗	⊗	⊗	⊗	⊗	⊗
4	Antwerp Diamond Bank N.V	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
5	Arab Bangladesh Bank Ltd	⊗	⊗	⊗	⊗	X	⊗	√	√	X	X	√	⊗	X	X	X	X
6	Bank Internasional Indonesia	√	√	X	√	√	√	√	√	X	√	X	⊗	√	√	√	√
7	Bank Muscat SAOG	⊗	⊗	⊗	X	⊗	⊗	⊗	X	√	√	√	X	√	√	⊗	⊗
8	Bank of America NA	√	√	√	X	√	⊗	⊗	⊗	⊗	√	√	√	⊗	⊗	⊗	X
9	Bank of Bahrain and Kuwait BSC	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	X	⊗	⊗	⊗	⊗	⊗	⊗
10	Bank of Ceylon	⊗	⊗	⊗	⊗	X	⊗	⊗	⊗	√	X	√	⊗	⊗	⊗	⊗	⊗
11	Barclays Bank PLC	⊗	⊗	⊗	√	√	⊗	⊗	√	⊗	√	√	√	√	X	X	√
12	BNP Paribas	⊗	⊗	⊗	⊗	⊗	⊗	⊗	√	√	X	X	X	√	X	X	X
13	Chinatrust Commercial Bank	⊗	⊗	X	X	⊗	⊗	X	X	⊗	X	√	√	⊗	X	√	√
14	Chohung Bank	X	X	√	√	√	⊗	√	√	√	X	X	√	X	√	⊗	⊗
15	Citibank NA	√	√	√	√	X	X	√	√	X	X	X	X	⊗	√	⊗	⊗
16	Credit Agricole Indosuez	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	√	√	√	⊗	⊗	⊗	⊗	⊗
17	Crediti Lyonnais	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	X	√	⊗	⊗	⊗	⊗	⊗
18	Deutsche Bank AG	⊗	X	√	X	X	X	X	X	⊗	⊗	X	√	⊗	⊗	⊗	⊗
19	ING Bank	⊗	⊗	⊗	⊗	√	⊗	⊗	√	√	√	⊗	⊗	⊗	⊗	⊗	√

20	JP Morgan Chase Bank	X	X	√	X	√	√	√	X	√	⊗	√	√	⊗	⊗	⊗	⊗
21	Krung Thai Bank Public Company Ltd	√	X	X	⊗	√	√	X	X	√	√	√	√	⊗	⊗	X	⊗
22	Mashreq Bank psc	⊗	⊗	X	X	√	⊗	X	√	⊗	⊗	√	√	⊗	⊗	X	⊗
23	MIZUHO Corporate Bank Ltd	⊗	⊗	⊗	⊗	⊗	X	⊗	√	X	√	√	X	⊗	⊗	⊗	⊗
24	Oman Internatinal Bank SAOG	⊗	⊗	⊗	⊗	⊗	⊗	√	X	X	√	√	⊗	⊗	⊗	⊗	⊗
25	Oversea-Chinese Banking Corporation Ltd	⊗	⊗	√	⊗	X	⊗	√	√	√	√	√	√	√	√	√	√
26	Societe Generale	⊗	⊗	⊗	⊗	⊗	⊗	√	⊗	⊗	X	√	√	⊗	⊗	⊗	⊗
27	Sonali Bank	⊗	⊗	⊗	⊗	⊗	X	X	√	√	√	√	⊗	⊗	√	√	√
28	Standard Chartered Bank	⊗	X	X	X	⊗	X	⊗	X	⊗	X	X	⊗	⊗	⊗	⊗	⊗
29	State Bank of Mauritius	X	X	⊗	⊗	X	X	⊗	⊗	⊗	X	X	⊗	⊗	⊗	⊗	⊗
30	Sumitomo Mitsui Banking Corporation	⊗	⊗	⊗	X	⊗	⊗	X	√	⊗	√	√	⊗	⊗	⊗	⊗	⊗
31	The Bank of Nova Scotia	X	X	X	X	√	⊗	√	X	√	√	X	⊗	⊗	⊗	⊗	⊗
32	The Bank of Tokyo – Mitsubishi Ltd	√	⊗	X	⊗	√	√	X	X	X	√	⊗	√	⊗	√	X	√
33	The Develoment Bank of Singapore Ltd	⊗	X	X	⊗	X	⊗	X	⊗	⊗	X	X	√	⊗	X	⊗	⊗
34	The Hongkong & Shanghai Banking Crop. Ltd	⊗	⊗	X	⊗	⊗	⊗	√	⊗	⊗	X	X	⊗	⊗	⊗	⊗	⊗
35	The Toronto Dominion Bank	√	√	⊗	⊗	√	√	√	√	X	√	√	√	⊗	⊗	⊗	⊗
36	UFJ Bank Ltd	X	√	√	⊗	√	√	X	X	⊗	X	⊗	⊗	⊗	⊗	⊗	⊗

Note: **'√' indicates that the bank is efficient, i.e., DEA score is one**
X indicates that the bank is less efficient, i.e., DEA score range is [0.5, 1)
⊗ indicates that the bank is inefficient, i.e., DEA score less than 0.5.

PRIVATE SECTOR BANKS:

From table 4.2. we can find that most of the private banks are in the inefficient range in all the performance indicators in the sample period.

For the productivity, except SBI Commercial and international Bank Ltd.. Indusland Bank Ltd. Bank of Punjab, no banks are found to be efficient. Most of the banks are found to be in the range of inefficient.

For the profitability, comparative to the productivity indicator many banks are found to be less efficient. Bank of Punjab Limited. Centurion Bank. UTI Bank limited. The Catholic Syrian Bank Limited. the Karur Vysya Bank Limited have performed efficiently with the score unity.

For the Financial Management, all banks of the efficiency score is greater than the inefficient level except Kotak Mahindra Bank Limited. the Sangli Bank Limited. There are good number of banks which are having efficiency score unity namely The National Bank Limited. SBI Commercial and International Bank Limited. Tamilnad Mercantile Bank Limited, The Ganesh Bank of Kurundwad Limited. Centurion Bank. Global Trust Bank, HDFC. ICICI and UTI Bank Limited.

For the asset quality, most of the banks are found to be inefficient. The National Bank Limited, the Ganesh Bank of Kurundwad Limited. HDFC are found efficient with the score and rank unity.

Finally, from all the above analysis, we found that the National Bank Limited, SBI Commercial and International Bank Limited. The Ganesh Bank of Kurundwad Limited, Bank of Punjab Limited. Global Trust Bank. HDFC. 1CIC1, and UTI Bank Limited are found efficient in all the indicators throughout the sample period.

FOREIGN BANKS:

As noted in the objectives of this study, we deal foreign banks in a separated category. After 1998 WTO Regulation Act. foreign banks are effectively performance better than the previous years. It indicates that in the sample period foreign banks are having wide disparities in the efficiency.

From above table 4.3. many banks are found to inefficient range. For the productivity, Citi Bank NA. Abu Dhabii Commercial Bank Limited. Bank of Internasional Indonesia. Bank of America NA are found to be efficient with a score unity.

For the profitability. Bank of Internasional Indonesia. JP Morgan Chese Bank, the Toronto Dominion Bank are found to efficient with score unity, and many other banks also indicate relatively efficient.

For the financial management, many banks are lying between [0.5.1): and the banks called. Oversea-Chinese Banking corporation limited. the Toronto Dominion Bank. Krung Thai Bank Public Company Limited. Bank of Muscat SAOG. Bank of America NA, credit Agricole Indosuez are being efficient with the score unity and many others also following to the efficient banks.

For the Asset Quality, Bank of Internasional Indonesia, Oversea-Chinese Banking Corporation Limited are found efficient and most of the remaining banks score range lies between [0, 0.5]. so they are inefficient in this category.

After implementing of WTO Act. in 1998. the foreign banks in India. have become efficient. They improved their performance in terms of productivity, profitability, financial management and asset quality. From the analysis, we find that Bank of Internasional Indonesia. Citi Bank NA. Oversea-Chinese Banking corporation limited. the Bank of Tokyo-Mitsobishi Limited are found relatively efficient in the study period.

43 COMPARISON OF EFFICIENCY/PERFORMANCE INDICATORS BETWEEN THE COMMERCIAL BANKS:

From tables 4.4 to 4.8 we can compare the various performance indicators according to their performance levels in the commercial banks during the study period.

Table 4.4

Comparison of **Productivity** of the Commercial banks

Year/ efficiency	Public Sector Banks			Private Banks			Foreign Banks		
	Effic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.
1999-2000	2	4	21	3	18	9	6	6	24
2000-2001	3	5	19	5	3	22	6	10	20
2001-2002	3	10	14	5	3	22	8	8	20
2002-2003	3	11	13	4	6	20	5	9	22

Table 4.5

Comparison of Profitability between Commercial Banks

Year/ efficiency	Public Sector Banks			Private Banks			Foreign Banks		
	Effic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.
1999-2000	II	14	2	16	14	0	12	8	16
2000-2001	11	16	0	9	5	16	6	7	23
2001-2002	10	17	0	9	19	2	11	10	15
2002-2003	9	18	0	11	7	12	14	10	12

Table 4.6

Comparison of Financial Management between Commercial Banks

Year/ efficiency	Public Sector Banks			Private Banks			Foreign Banks		
	Effic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.
1999-2000	10	17	0	14	14	2	13	8	15
2000-2001	13	14	0	14	14	2	15	16	5
2001-2002	9	18	0	14	16	0	19	11	6
2002-2003	11	16	0	10	19	1	13	4	19

Table 4.7

Comparison of Asset Quality between Commercial Banks

Year/ efficiency	Public Sector Banks			Private Banks			Foreign Banks		
	I ffic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.	Effic.	Less effi.	Ineffi.
1999-2000	4	14	9	4	2	24	6	2	28
2000-2001	6	15	6		7	20	8	4	24
2001-2002	6	14	7	3	6	21	5	3	28
2002-2003	6	14	7	3	1	26	7	1	28

From all the above tables. we can evaluate the efficiency/indicators of the different banks in the sample period having difTerent efTiciencv levels. such as: many of the public sector banks are having high efficiency in terms of productivity, profitability, financial management and asset qualin. whereas the private banks are having a very high inefficiency levels during the sample period in the different indicators. Whereas the foreign banks. with new entry the banks are operating with a new kind of performance i.e. these banks are raise their efficiency levels during the period in productivity, profitability, financial management and asset quality.

Table 4.8
Overall efficiency/performance indicators for the sample period

Public Banks	Productivity						Profitability						Financial Management						Asset Quality					
	Effic.	%	Less effi.	%	Ineffi.	%	Effic.	%	Less effi.	%	Ineffi.	%	Effic.	%	Less effi.	%	Ineffi.	%	Effic.	%	Less effi.	%	Ineffi.	%
1999-2000	2	7	4	15	21	78	11	41	14	52	2	7	10	37	17	63	0	0	4	15	14	52	9	33
2000-2001	3	11	5	19	19	70	11	41	16	59	0	0	13	48	14	52	0	0	6	22	15	56	6	22
2001-2002	3	11	10	37	14	52	10	37	17	63	0	0	9	33	18	67	0	0	6	22	14	52	7	26
2002-2003	3	11	11	41	13	48	9	33	18	67	0	0	11	41	16	59	0	0	6	22	14	52	7	26
Private Bank																								
1999-2000	3	10	18	60	9	30	16	53	14	47	0	0	14	46	14	47	2	7	4	13	2	7	24	80
2000-2001	5	19	3	10	22	73	9	30	5	17	16	53	14	46	14	47	2	7	3	10	7	23	20	67
2001-2002	5	17	3	10	22	73	9	30	19	63	2	7	14	47	16	53	0	0	3	10	6	20	21	70
2002-2003	4	13	6	20	20	67	11	37	7	23	12	40	10	33	19	64	1	3	3	10	1	3	26	87
Foreign Banks																								
1999-2000	6	17	6	17	24	66	12	33	8	22	16	45	13	36	8	22	15	42	6	17	2	6	28	77
2000-2001	6	17	10	28	20	55	6	17	7	19	23	64	15	42	16	44	5	14	8	22	4	11	24	67
2001-2002	8	22	8	22	20	56	11	31	10	28	15	41	19	52	11	31	6	17	5	14	3	8	28	78
2002-2003	5	14	9	25	22	61	14	39	10	28	12	33	13	36	4	11	19	53	7	19	1	3	28	78

Source: Authors calculations.

4.4 CONCLUDING REMARKS AND SUGGESTIONS:

The study presents application of DEA to determine performance efficiency record of Indian Scheduled Commercial Banks for different indicators such as productivity, profitability, financial management and asset quality. Results show the relative efficiency of banks to its peer units. The relative efficiency of public sector banks is found to be efficient in all indicators. Hence PSBs stood first in ranking among all the banks. The public sector banks are followed by foreign banks then followed by private banks.

Although DEA has fewer limitations than other performance measurement approaches in the choice of input and output variables. the efficiency measure obtain by DEA is sensitive to the combination of inputs and outputs. If inputs and outputs are properly chosen, DEA can provide crucial information about bank's financial condition and management performance. Although DEA can identify performance target with respect to reference units, it does not tell us how to achieve these targets.

APPENDIX-I

NAME OF THE BANKS IN INDIA

PUBLIC SECTOR BANKS

S.No	NATIONALISED BANKS
1	Allahabad Bank
2	Andhra Bank
3	Bank of Baroda
4	Bank of India
5	Bank of Maharashtra
6	Canara Bank
7	Central Bank of India
8	Corporation Bank
9	Dena Bank
10	Indian Bank
11	Indian Overseas Bank
12	Oriental Bank of Commerce
3	Punjab & Sind Bank
14	Punjab National Bank
15	Syndicate Bank
16	UCO Bank
17	Jnion Bank of India
18	United Bank of India
19	Vijaya Bank
	SBI and Associates of **SBI**
20	**State Bank of India (SBI)**
21	State Bank of Bikaner & Jaipur
:	State Bank of Hyderabad
23	State Bank of Indore
24	State Bank of Mysore
25	State Bank of Patiala
26	State Bank of Saurashtra
27	State Bank of Travancore

INDIAN PRIVATE BANKS

S.No	OLD PRIVATE BANKS
I	Bharat Overseas Bank Ltd.
2	City Union Bank Ltd.
3	Development Credit Bank Ltd.
4	ING Vysya Bank Ltd
5	Karnataka Bank Ltd.
6	Lord Krishna Bank Ltd.
7	The Nainital Bank Ltd.
8	SBI Coml. and Intl. Bank Ltd.
9	Tamilnad Mercantile Bank Ltd.
10	The Bank of Rajasthan Ltd.
11	The Catholic Syrian Bank Ltd.
12	The Dhanalakshmi Bank Ltd.
13	**The** Federal Bank Ltd.
14	The Ganesh Bank of Kurundwad Ltd.
15	The **Jammu** & Kashmir Bank Ltd.
16	The **Karur** Vvsva Bank Ltd.
17	The Lakshmi Vilas Bank Ltd.
18	The Ratnakar Bank Ltd.
19	**The** Sangli Bank Ltd.
20	The South Indian Bank Ltd.
21	**The** United Western Bank Ltd.
	NEW PRIVATE SECTOR BANKS
22	Bank **of Punjab** Ltd.
23	**Centurion Bank** Ltd.
24	**Global** Trust Bank Ltd.
25	HDFC **Bank** Ltd.
26	ICICI **Bank** Ltd.
27	IDBI **Bank** Ltd.
8	IndusInd **Bank Ltd.**
29	Kotak **Mahindra Bank** Ltd
	UTI Bank **Ltd.**

FOREIGN BANKS IN INDIA

S.No	**Name** of the **Banks**
1	ABN-Amro Bank N.V.
2	Abu Dhabi Commercial Bank Ltd.
3	American Express Bank Ltd.
4	Antwerp Diamond Bank N.V
5	Arab Bangladesh Bank Ltd.
6	Bank International Indonesia
7	Bank Muscat SAOG
8	Bank of America NA
9	Bank of Bahrain and Kuwait BSC
10	Bank of Ceylon
11	Barclays Bank PLC
12	BNP Paribas
13	Chinatrust Commercial Bank
14	Chohung Bank
15	Citibank N.A.
16	Credit Agricole Indosuez
17	Credit Lyonnais
18	Deutsche Bank AG
19	ING Bank
20	JP Morgan Chase Bank
21	Krung Thai Bank Public Company Ltd.
22	MashreqBank psc
23	MIZUHO Corporate Bank Ltd.
24	Oman International Bank SAOG
25	Oversea-Chinese Banking Corporation Ltd.
26	SocieteGenerale
27	Sonali Bank
28	Standard Chartered Bank
29	State Bank of Mauritius Ltd.
30	Sumitomo Mitsui Banking Corporation
31	The Bank of Nova Scotia
32	The Bank of Tokyo - Mitsubishi Ltd.
33	**The** Development Bank of Singapore Ltd.
34	**The** Hongkong & Shanghai Bkg.Corp.Ltd.
35	**The Toronto** Dominion Bank
36	**UFJ Bank Ltd.**

APPENDIX **II**

Table A.1
DEA **score and Ranks** of Productivity of Pubiic Sector Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Allahabad Bank	0.398680203	16	0.521962224	8	0.524390244	10	0.935879106	4
2	Andhra Bank	0.440282397	13	0.493734179	9	0.546153846	8	0.614843887	6
3	Bank of Baroda	0.532638008	5	0.571831718	7	0.576136364	5	0.54736235	13
4	Bank of India	0.46598375	10	0.429027696	17	0.490156394	14	0.553050518	12
5	Bank of Maharashtra	0.342756736	20	0.391409073	21	0.514285714	11	0.544895546	14
6	Canara Bank	0.491969447	7	0.472058549	11	0.50222618	13	0.600472321	8
7	Central Bank of India	0.296992732	25	0.364460205	22	0.33458445	24	0.341059149	24
8	Corporation Bank	1	1	1	1	1	1	1	1
9	Dena Bank	0.472237141	9	0.447756316	13	0.512693498	12	0.471724488	16
10	Indian Bank	0.328229734	22	0.358795881	23	0.347424512	23	0.37002584	22
11	Indian Overseas Bank	0.363766726	19	0.438889419	15	0.409090909	21	0.375400517	21
12	Oriental Bank of Commerce	1	1	1	1	1	1	1	1
13	Punjab & Sind Bank	0.455468389	12	0.441809092	14	0.427046263	20	0.37541105	20
14	Punjab National Bank	0.336723144	21	0.401518576	20	0.440425532	18	0.468696036	17
15	Syndicate Bank	0.31900025	23	0.315566611	25	0.313235294	25	0.330593707	25
16	UCO Bank	0.27344957	26	0.293786867	27	0.262008734	26	0.305439838	26
17	Union Bank of India	0.484746691	8	0.493451912	10	0.489082969	15	0.56856246	10
18	United Bank of India	0.239365679	27	0.297619048	26	0.195092025	27	0.274776386	27
19	Vijaya Bank	0.459586099	11	0.464216634	12	0.454901961	17	0.355266439	23
20	State Bank of India (SBI)	0.615884085	3	1	1	1	1	1	1
21	State Bank of Bikaner & Jaipur	0.398237717	17	0.428126622	18	0.460899654	16	0.48372093	15
22	State Bank of Hyderabad	0.579286913	4	0.574445991	6	0.559717314	7	0.558503144	11
23	State Bank of Indore	0.520170986	6	0.62228323	5	0.564705882	6	0.58817596	9
24	State Bank of Mysore	0.310236507	24	0.333156659	24	0.357024793	22	0.384096024	19
25	State Bank of Patiala	0.433468858	14	0.433412136	16	0.527419355	9	0.604438132	7
26	State Bank of Saurashtra	0.409996095	15	0.650813517	4	0.693877551	4	0.714418605	5
27	State Bank of Travancore	0.387325723	18	0.419899122	19	0.431020408	19	0.438212155	18

Table A.2
DEA score and Ranks of Productivity of Private Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Bharat Overseas Bank Ltd.	0.11827957	11	0.125554851	12	0.165816327	14	0.195164672	13
2	City Union Bank Ltd.	6.51E-02	19	6.71E-02	20	8.07E-02	20	0.104938272	21
3	Development Credit Bank Ltd.	0.154673284	10	0.174588232	10	0.184319173	11	0.214520615	11
4	ING Vysya Bank Ltd	9.63E-02	12	8.24E-02	15	0.112755102	16	0.145579105	14
5	Karnataka Bank Ltd.	0.047311828	25	5.12E-02	23	6.26E-02	26	9.20E-02	23
6	Lord Krishna Bank Ltd.	8.60E-02	14	9.29E-02	14	0.182397959	12	0.209876543	12
7	The Nainital Bank Ltd.	3.55E-02	29	4.02E-02	26	4.23E-02	29	6.59E-02	28
8	SBI Coml. and Intl. Bank Ltd.	1	1	1	1	1	1	1	1
9	Tamilnad Mercantile Bank Ltd.	7.21E-02	16	6.81E-02	19	9.10E-02	18	0.10687873	20
10	The Bank of Rajasthan Ltd.	4.99E-02	23	5.61E-02	22	7.20E-02	22	8.32E-02	25
11	The Catholic Syrian Bank Ltd.	4.21E-02	26	0.035552044	28	4.36E-02	28	5.05E-02	29
12	The Dhanalakshmi Bank Ltd.	6.45E-02	20	5.03E-02	24	6.63E-02	24	8.48E-02	24
13	The Federal Bank Ltd.	5.91E-02	21	6.25E-02	21	7.67E-02	21	9.40E-02	22
14	The Ganesh Bank of Kurundwad Ltd.	6.74E-02	18	0.139190505	11	0.171750722	13	0.12947112	16
15	The Jammu & Kashmir Bank Ltd.	9.20E-02	13	0.077936747	16	9.00E-02	19	0.116844892	19
16	The Karur Vysya Bank Ltd.	7.01E-02	17	0.108433735	13	0.137388652	15	0.12916343	17
17	The Lakshmi Vilas Bank Ltd.	7.89E-02	15	7.70E-02	17	9.95E-02	17	0.143246695	15
18	The Ratnakar Bank Ltd.	5.91E-02	22	7.59E-02	18	0.066326531	25	0.127183099	18
19	The Sangli Bank Ltd.	3.70E-02	27	2.85E-02	29	3.74E-02	30	4.84E-02	30
20	The South Indian Bank Ltd.	3.58E-02	28	3.83E-02	27	5.84E-02	27	7.87E-02	26
21	The United Western Bank Ltd.	4.84E-02	24	4.54E-02	25	6.73E-02	23	7.32E-02	27
22	Bank of Punjab Ltd.	0.857526882	4	1	1	1	1	1	1
23	Centurion Bank Ltd.	1	1	1	1	0.971314063	6	0.868540937	5
24	Global Trust Bank Ltd.	0.842994979	5	0.688711444	7	0.626956286	7	0.656988574	8
25	HDFC Bank Ltd.	0.306947061	9	1	1	1	1	0.695320042	7
26	ICICI Bank Ltd.	0.404082968	8	0.59012975	8	0.589080413	8	1	1
27	IDBI Bank Ltd.	0.475154758	6	0.405263825	9	0.409294559	9	0.540099229	10
28	IndusInd Bank Ltd.	1	1	1	1	1	1	1	1
30	UTI Bank Ltd.	0.438614402	7	0.813491365	6	0.322157434	10	0.648642718	9
						1	1	0.699017857	6

Table A.3
DEA score and Ranks of Productivity of Foreign Banks

S.NO	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	ABN-Amro Bank N.V.	0.576907315	11	0.577865899	13	0.477010515	18	0.587181712	9
2	Abu Dhabi Commercial Bank Ltd.	0.411017955	14	1	1	1	1	1	1
3	American Express Bank Ltd.	0.271705203	22	0.727332263	10	0.501506716	16	0.493361439	15
5	Arab Bangladesh Bank Ltd.	7.74E-02	33	0.219818303	28	0.232745201	29	0.490247752	16
6	Bank Internasional Indonesia	1	1	1	1	0.607981643	13	0.17276112	33
7	Bank Muscat SAOG	0.249136427	23	0.395011024	19	0.411051505	19	1	1
8	Bank of America NA	1	1	1	1	1	1	0.522611302	14
9	Bank of Bahrain and Kuwait BSC	0.239190378	24	0.258976018	27	0.28841592	26	0.585852544	11
10	Bank of Ceylon	0.377092978	17	0.303006586	22	0.199352751	32	0.295425114	27
11	Barclays Bank PLC	0.193272467	30	0.283809111	24	0.379212845	21	0.401181841	19
12	BNP Paribas	0.151841501	31	0.143675499	33	0.262627454	28	1	1
13	Chinatrust Commercial Bank	0.308716877	20	0.403673281	18	0.654131911	11	0.330222011	26
14	Chohung Bank	0.531012122	12	0.779541067	9	1	1	0.604713396	8
15	Citibank N.A.	1	1	1	1	1	1	1	1
16	Credit Agricole Indosuez	0.207489593	29	0.169754909	31	0.32740054	23	1	1
17	Credit Lyonnais	0.290304984	21	0.268245708	26	0.302977595	25	0.391430399	20
18	Deutsche Bank AG	0.409026042	15	0.630626693	12	1	1	0.357057479	21
19	ING Bank	0.238693463	25	0.185865251	30	0.192354369	33	0.938614367	7
20	JP Morgan Chase Bank	0.590319572	10	0.912825155	7	1	1	0.190780163	31
21	Krung Thai Bank Public Company Ltd.	1	1	0.539808628	16	0.577505334	15	0.190925368	30
22	MashreqBank psc	0.329033367	19	0.394672609	20	0.318470995	24	0.343595517	24
24	Oman International Bank SAOG	0.472365728	13	0.187033237	29	1	1	0.956621405	6
25	Oversea-Chinese Banking Corporation Ltd.	0.150947549	32	0.269328672	25	0.229205346	30	0.40339074	18
26	Societe Generale	0.216432927	28	0.151194799	32	0.202933424	31	0.333333333	25
27	Sonali Bank	5.78E-02	34	0.121768679	34	0.617044157	12	0.204939273	29
28	Standard Chartered Bank	0.398524721	16	0.572400032	14	0.341545474	22	0.166666667	34
29	State Bank of Mauritius Ltd.	0.670354402	8	0.653699822	11	0.381735258	20	0.58012854	12
30	Sumitomo Mitsui Banking Corporation	0.229476886	27	0.371285731	21	0.98761195	9	0.353727691	23
31	The Bank of Nova Scotia	0.650398387	9	0.791921994	8	0.596099104	14	0.525551044	13
32	The Bank of Tokyo - Mitsubishi Ltd.	1	1	0.412446558	17	0.762975903	10	0.586806629	10
33	The Development Bank of Singapore Ltd.	0.35291642	18	0.548413387	15	0.489756466	17	0.111797323	35
34	The Hongkong & Shanghai Bkg.Corp.Ltd.	0.23252571	26	0.284856227	23	0.26569506	27	0.264200495	28
35	The Toronto Dominion Bank	1	1	1	1	1	1	0.354253493	22
36	UFJ Bank Ltd.	0.960919667	7	1	1			0.17764345	32
								0.424238056	17

Table A.4
DEA score and Ranks of Prontability of Public Sector Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Allahabad Bank	0.743751878	17	0.998282001	12	0.937641126	12	1	1
2	Andhra Bank	0.659808497	20	0.675256911	23	0.821805737	19	0.947091662	13
3	Bank of Baroda	0.839191109	13	0.920434243	13	0.856127933	14	0.775267204	24
4	Bank of India	0.832355667	14	0.676724977	22	0.791200359	23	0.801796976	20
5	Bank of Maharashtra	0.634169966	23	0.596713507	26	0.835063434	17	0.771152001	26
6	Canara Bank	0.828894242	15	0.699008018	21	0.799010469	22	0.790532866	22
7	Central Bank of India	0.54573501	25	0.633463548	25	0.840455165	16	0.924750129	14
8	Corporation Bank	1	1	1	1	1	1	1	1
9	Dena Bank	1	1	1	1	1	1	1	1
10	Indian Bank	1	1	1	1	0.665942907	27	0.776603307	23
11	Indian Overseas Bank	0.620924071	24	0.670949065	24	0.763697411	24	0.811510964	19
12	Oriental Bank of Commerce	1	1	1	1	1	1	1	1
13	Punjab & Sind Bank	1	1	0.73311388	16	0.80150441	21	1	1
14	Punjab National Bank	0.655183803	21	0.728000348	19	0.848468358	15	0.992591865	10
15	Syndicate Bank	0.673400925	18	0.737584823	15	0.939930022	11	0.953400624	11
16	UCO Bank	0.450666864	26	0.550739213	27	0.667767843	26	0.687707515	27
17	Union Bank of India	0.789784104	16	0.729534255	17	0.865788772	13	0.817049266	18
18	United Bank of India	0.415751844	27	1	1	1	1	1	1
19	Vijaya Bank	0.663853599	19	0.714198854	20	0.8315932	18	0.913643554	15
20	State Bank of India (SBI)	0.964589549	12	0.851620574	14	0.811673518	20	0.800443403	21
21	State Bank of Bikaner & Jaipur	1	1	1	1	1	1	0.952180455	12
22	State Bank of Hyderabad	1	1	1	1	1	1	0.853253225	17
23	State Bank of Indore	1	1	1	1	1	1	1	1
24	State Bank of Mysore	1	1	1	1	1	1	1	1
25	State Bank of Patiala	1	1	1	1	1	1	1	1
26	State Bank of Saurashtra	1	1	1	1	1	1	0.913288555	16
27	State Bank of Travancore	0.642359848	22	0.728236953	18	0.747834043	25	0.772688097	25

Table A.5
DEA score **and Ranks of Profitability of Private Banks**

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Bharat Overseas Bank Ltd.	1	1	0.538516555	14	0.847233382	16	0.763171148	15
2	City Union Bank Ltd.	1	1	0.64095042	12	0.805921702	17	0.512937524	18
3	Development Credit Bank Ltd.	0.712611331	26	0.351838435	17	0.713708659	22	0.296646189	23
4	ING Vysya Bank Ltd	0.829496667	24	9.61E-02	25	0.608699784	28	0.16646404	26
5	Karnataka Bank Ltd.	0.628725176	28	0.139628784	22	0.62307855	26	0.431111261	21
6	Lord Krishna Bank Ltd.	0.649234881	27	0.136459021	23	1	1	1	1
7	The Nainital Bank Ltd.	1	1	5.11E-02	28	1	1	0.101552575	28
8	SBI Coml. and Intl. Bank Ltd.	1	1	1	1	0.294090959	30	0.328103127	22
9	Tamilnad Mercantile Bank Ltd.	0.843033533	23	0.688191602	11	0.615291543	27	0.191927204	25
10	The Bank of Rajasthan Ltd.	0.992451694	17	0.206531164	20	0.925674814	13	0.786561919	14
11	The Catholic Syrian Bank Ltd.	1	1	0.197059236	21	1	1	1	1
12	The Dhanalakshmi Bank Ltd.	0.927784954	19	9.25E-02	26	0.799045784	18	0.254087405	24
13	The Federal Bank Ltd.	0.866573696	22	0.208628469	19	0.989715262	10	0.47025138	19
14	The Ganesh Bank of Kurundwad Ltd.	0.621191814	29	0.125881337	24	0.659795335	25	0.107251911	27
15	The Jammu & Kashmir Bank Ltd.	1	1	1	1	0.987043649	11	1	1
16	The Karur Vysya Bank Ltd.	1	1	1	1	1	1	0.908234689	12
17	The Lakshmi Vilas Bank Ltd.	1	1	1	1	0.773368427	19	0.434891088	20
18	The Ratnakar Bank Ltd.	1	1	0.299487268	18	1	1	1	1
19	The Sangli Bank Ltd.	0.878694455	21	0.033670713	29	0.726980876	21	8.57E-02	29
20	The South Indian Bank Ltd.	0.928987224	18	0.454560722	16	0.873494544	14	0.60851522	17
21	The United Western Bank Ltd.	1	1	0.05176532	27	0.695068046	24	7.49E-02	30
22	Bank of Punjab Ltd.	1	1	1	1	1	1	1	1
23	Centurion Bank Ltd.	1	1	1	1	1	1	0.885214566	13
24	Global Trust Bank Ltd.	1	1	1	1	0.735962209	20	1	1
25	HDFC Bank Ltd.	1	1	1	1	0.871760227	15	1	1
26	ICICI Bank Ltd.	0.721383581	25	0.613416343	13	0.4439265	29	1	1
27	IDBI Bank Ltd.	1	1	0.473190142	15	0.976127694	12	1	1
28	IndusInd Bank Ltd.	1	1	0.720923657	10	0.708281791	23	0.681805217	16
30	UTI Bank Ltd.	0.906521736	20	1	1	1	1	1	1
						1	1	1	1

Table A.6

DEA score and Ranks of Profitability of Foreign Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	ABN-Amro Bank N.V.	0.876286082	15	0.375077135	21	0.711709752	18	0.788830739	20
2	Abu Dhabi Commercial Bank Ltd.	0.389599548	28	0.216214665	28	0.276591459	31	0.533609369	24
3	American Express Bank Ltd.	0.433531876	24	0.741963039	8	0.988080422	13	1	1
5	Arab Bangladesh Bank Ltd.	0.54803791	19	0.387235121	19	1	1	0.421774211	30
6	Bank Internasional Indonesia	1	1	1	1	1	1	1	1
7	Bank Muscat SAOG	0.307409779	34	0.475145482	14	0.476264631	24	1	1
8	Bank of America NA	1	1	0.294547968	24	0.487169071	22	0.60307595	23
9	Bank of Bahrain and Kuwait BSC	0.416257035	26	0.265703332	25	0.334568064	29	0.39360427	33
10	Bank of Ceylon	0.906122927	14	0.421409649	16	0.259806071	34	0.451526846	28
11	Barclays Bank PLC	1	1	0.233888277	27	0.398292232	25	0.431949167	29
12	BNP Paribas	0.339368112	32	0.154722936	33	0.2651947	33	1	1
13	Chinatrust Commercial Bank	0.425889036	25	0.458097094	15	0.91023366	14	1	1
14	Chohung Bank	1	1	0.420156246	17	1	1	0.954367027	16
15	Citibank N.A.	0.966986249	13	0.723403945	9	1	1	1	1
16	Credit Agricole Indosuez	0.112721239	35	0.100577008	35	0.338167051	28	1	1
17	Credit Lyonnais	0.392831956	27	0.122150781	34	0.318601181	30	0.281716344	36
18	Deutsche Bank AG	0.593405621	18	0.603719911	10	0.797717367	15	0.404190963	32
19	ING Bank	1	1	0.260926609	26	0.275685956	32	0.934951819	17
20	JP Morgan Chase Bank	1	1	1	1	1	1	1	1
21	Krung Thai Bank Public Company Ltd.	1	1	1	1	0.559970053	20	0.647508593	21
22	MashreqBank psc	1	1	0.202066475	29	0.990213179	12	0.893752887	18
23	MIZUHO Corporate Bank Ltd.	0.443869477	22	0.558069072	12	0.338413571	27	1	1
24	Oman International Bank SAOG	0.347537301	31	0.178634861	31	1	1	1	1
25	Oversea-Chinese Banking Corporation Ltd.	0.517138148	20	0.394903293	18	1	1	0.845848924	19
26	Societe Generale	0.3241532	33	0.175431441	32	1	1	1	1
27	Sonali Bank	0.389572697	29	0.89481351	7	0.761701989	17	0.320348032	34
28	Standard Chartered Bank	0.439911621	23	0.603211627	11	0.476885748	23	1	1
29	State Bank of Mauritius Ltd.	0.749469812	16	0.509122718	13	0.341236495	26	0.994099161	15
30	Sumitomo Mitsui Banking Corporation	0.377004331	30	0.201533527	30	0.541203759	21	0.486305118	26
31	The Bank of Nova Scotia	1	1	0.374788427	22	1	1	1	1
32	The Bank of Tokyo - Mitsubishi Ltd.	1	1	1	1	0.775112167	16	0.515701879	25
33	The Development Bank of Singapore Ltd.	0.748481817	17	0.369432132	23	0.588825965	19	0.625411364	22
34	The Hongkong & Shanghai Bkg.Corp.Ltd.	0.453847871	21	0.379797289	20	1	1	0.301240898	35
35	The Toronto Dominion Bank	1	1	1	1	1	1	0.459809326	27
36	UFJ Bank Ltd.	1	1	1	1			1	1

Table A.7
DEA score and Ranks of Financial Management of Public Sector Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Allahabad Bank	0.822871549	21	0.850929283	21	0.811405835	24	0.95576856	16
2	Andhra Bank	1	1	1	1	1	1	1	1
3	Bank of Baroda	0.888618415	16	1	1	0.938889854	14	0.966804089	15
4	Bank of India	1	1	1	1	1	1	1	1
5	Bank of Maharashtra	0.855827054	17	0.799382495	25	0.948722337	13	0.984189979	13
6	Canara Bank	0.914258827	14	0.907654173	17	1	1	1	1
7	Central Bank of India	0.76726401	25	0.791167323	26	0.765857549	26	0.870522187	24
8	Corporation Bank	1	1	1	1	1	1	1	1
9	Dena Bank	0.982445376	12	1	1	0.986869635	10	0.955325427	17
10	Indian Bank	1	1	1	1	1	1	0.969158958	14
11	Indian Overseas Bank	0.931054813	13	0.893206355	18	0.860525603	20	0.917429653	21
12	Oriental Bank of Commerce	1	1	1	1	0.884111218	18	1	1
13	Punjab & Sind Bank	1	1	1	1	1	1	1	1
14	Punjab National Bank	0.833307966	20	0.816134534	24	0.833556277	23	0.829782775	26
15	Syndicate Bank	0.854385451	18	1	1	0.755166873	27	0.788291102	27
16	UCO Bank	0.900013808	15	0.90984925	16	0.938543762	15	1	1
17	Union Bank of India	1	1	1	1	0.892753639	17	0.99114998	12
18	United Bank of India	1	1	1	1	1	1	1	1
19	Vijaya Bank	0.815416392	22	0.833851027	22	1	1	0.892712575	23
20	State Bank of India (SBI)	0.843109164	19	0.853662341	20	0.962389043	12	1	1
21	State Bank of Bikaner & Jaipur	0.794680759	24	0.821996739	23	0.800673605	25	0.850683699	25
22	State Bank of Hyderabad	0.762329553	26	0.747900685	27	0.871833872	19	0.943763901	18
23	State Bank of Indore	0.809269031	23	0.864201168	19	0.854725015	21	0.905969049	22
24	State Bank of Mysore	0.999999989	11	0.928652726	15	0.894253451	16	0.937797461	20
25	State Bank of Patiala	0.713303116	27	1	1	1	1	1	1
26	State Bank of Saurashtra	1	1	1	1	0.838281597	22	0.942988665	19
27	State Bank of Travancore	1	1	0.944481419	14	0.970637959	11	1	1

Table A.8
DEA score and Ranks of Financial Management of **Private** Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Bharat Overseas Bank Ltd.	0.755376964	24	0.806376404	22	0.928144817	17	0.816699696	20
2	City Union Bank Ltd.	1	1	0.814831263	21	0.796094334	23	0.72825706	21
3	Development Credit Bank Ltd.	0.865435877	20	1	1	0.864026111	19	0.869926305	17
4	ING Vysya Bank Ltd.	1	1	0.872642114	18	0.89224116	18	0.934334901	15
5	Karnataka Bank Ltd.	0.968886839	17	0.796375882	23	1	1	0.868522842	18
6	Lord Krishna Bank Ltd.	1	1	0.717920812	25	1	1	1	1
7	The Nainital Bank Ltd.	1	1	1	1	1	1	1	1
8	SBI Coml. and Intl. Bank Ltd.	1	1	1	1	1	1	1	1
9	Tamilnad Mercantile Bank Ltd.	1	1	1	1	1	1	1	1
10	The Bank of Rajasthan Ltd.	0.718423523	26	0.68542288	26	0.615511546	28	0.46500135	30
11	The Catholic Syrian Bank Ltd.	0.660177448	27	0.771920565	24	0.617171922	27	0.663818148	25
12	The Dhanalakshmi Bank Ltd.	0.730027103	25	0.974218028	16	0.655479479	26	0.641207356	26
13	The Federal Bank Ltd.	1	1	0.943068901	17	0.852385153	21	0.90900905	16
14	The Ganesh Bank of Kurundwad Ltd.	1	1	1	1	1	1	1	1
15	The Jammu & Kashmir Bank Ltd.	0.978339818	16	1	1	1	1	0.994724916	11
16	The Karur Vysya Bank Ltd.	1	1	1	1	0.93433567	16	0.853722473	19
17	The Lakshmi Vilas Bank Ltd.	0.872015214	19	0.860694232	19	0.79560315	24	0.714342275	22
18	The Ratnakar Bank Ltd.	0.598754431	28	0.667222784	27	0.614212598	29	0.638200538	27
19	The Sangli Bank Ltd.	0.486382557	29	0.498615609	29	0.52818027	30	0.552513166	29
20	The South Indian Bank Ltd.	0.761536225	23	0.837946966	20	0.82475839	22	0.705668056	23
21	The United Western Bank Ltd.	0.837023893	22	0.507343135	28	0.74182407	25	0.665842587	24
22	Bank of Punjab Ltd.	0.85503769	21	0.986156822	15	1	1	0.616499226	28
23	Centurion Bank Ltd.	1	1	1	1	1	1	1	1
24	Global Trust Bank Ltd.	1	1	1	1	1	1	1	1
25	HDFC Bank Ltd.	1	1	1	1	1	1	0.954663787	13
26	ICICI Bank Ltd.	1	1	1	1	1	1	1	1
27	IDBI Bank Ltd.	0.978415307	15	1	1	0.99072708	15	1	1
28	IndusInd Bank Ltd.	0.886754061	18	1	1	0.859621246	20	0.977106187	12
30	UTI Bank Ltd.	1	1	1	1	1	1	1	1

Table A.9
DEA score and Ranks of Financial Management of Foreign Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	ABN-Amro Bank N.V.	1	1	0.616744497	27	0.776906237	22	0.284357695	25
2	Abu Dhabi Commercial Bank Ltd.	1	1	0.557974891	29	1	1	0.518212685	17
3	American Express Bank Ltd.	0.578391295	21	0.473681089	32	0.420945686	33	0.351146898	22
5	Arab Bangladesh Bank Ltd.	0.79441045	18	0.694999708	23	1	1	0.339338114	23
6	Bank Internasional Indonesia	0.69338882	20	1	1	0.684874124	25	0.139994741	30
7	Bank Muscat SAOG	1	1	1	1	1	1	0.440199852	19
8	Bank of America NA	0.477633465	22	1	1	1	1	1	1
9	Bank of Bahrain and Kuwait BSC	2.27E-02	34	0.908016427	18	0.443687001	31	6.58E-02	33
10	Bank of Ceylon	1	1	0.935797044	17	1	1	6.25E-02	34
11	Barclays Bank PLC	6.38E-02	31	1	1	1	1	1	1
12	BNP Paribas	1	1	0.757301127	21	0.880897832	21	0.641593967	15
13	Chinatrust Commercial Bank	0.145056244	26	0.855567544	19	1	1	1	1
14	Chohung Bank	1	1	0.535464668	30	0.528899122	29	1	1
15	Citibank N.A.	0.785546495	19	0.624997874	25	0.695267663	24	0.877090754	14
16	Credit Agricole Indosuez	1	1	1	1	1	1	6.81E-02	32
17	Credit Lyonnais	2.09E-02	35	0.951873568	16	1	1	0.396458545	21
18	Deutsche Bank AG	3.31E-02	33	0.397368347	33	0.725220771	23	1	1
19	ING Bank	1	1	1	1	0.199859404	35	0.270419359	26
20	JP Morgan Chase Bank	1	1	0.241899661	35	1	1	1	1
21	Krung Thai Bank Public Company Ltd.	1	1	1	1	1	1	1	1
22	MashreqBank psc	0.122000138	28	0.329360854	34	1	1	1	1
23	MIZUHO Corporate Bank Ltd.	0.991565054	14	1	1	1	1	0.630022277	16
24	Oman International Bank SAOG	0.979787738	15	1	1	1	1	8.07E-02	31
25	Oversea-Chinese Banking Corporation Ltd.	1	1	1	1	1	1	1	1
26	Societe Generale	3.40E-02	32	0.737240165	22	1	1	1	1
27	Sonali Bank	1	1	1	1	1	1	0.474653165	18
28	Standard Chartered Bank	0.17960809	24	0.57568207	28	0.627534801	27	0.39757319	20
29	State Bank of Mauritius Ltd.	0.131995905	27	0.622162615	26	0.639939195	26	3.14E-02	35
30	Sumitomo Mitsui Banking Corporation	0.275751327	23	1	1	1	1	0.167516163	27
31	The Bank of Nova Scotia	1	1	1	1	0.903963285	20	0.32373112	24
32	The Bank of Tokyo - Mitsubishi Ltd.	0.796278507	17	1	1	0.362840843	34	1	1
33	The Development Bank of Singapore Ltd.	7.92E-02	29	0.522966819	31	0.502665659	30	1	1
34	The Hongkong & Shanghai Bkg.Corp.Ltd.	0.178242942	25	0.651964566	24	0.626001366	28	0.163073355	28
35	The Toronto Dominion Bank	0.971030435	16	1	1	1	1	1	1
36	UFJ Bank Ltd.	6.70E-02	30	0.797189405	20	0.440621508	32	0.155773831	29

Table A.10
DEA score and Ranks of Asset Quality of Public Sector Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Allahabad Bank	0.476732109	19	0.440736545	24	0.476413261	22	0.431949496	24
2	Andhra Bank	0.752595073	8	0.946655552	7	1	1	0.983914083	7
3	Bank of Baroda	0.36693305	26	0.377899729	26	0.456521739	24	0.435571688	23
4	Bank of India	0.432934377	20	0.511454286	20	0.553895411	18	0.562946884	17
5	Bank of Maharashtra	0.659763781	11	0.57029666	16	0.618385268	16	0.56019453	18
6	Canara Bank	0.561458333	15	0.699858865	12	0.834405145	9	0.805369128	11
7	Central Bank of India	0.378931913	23	0.361327427	27	0.376178497	27	0.383923862	27
8	Corporation Bank	1	1	1	1	1	1	0.910815939	9
9	Dena Bank	0.714431434	9	1	1	1	1	0.918661389	8
10	Indian Bank	0.301987661	27	0.556168492	17	0.38617086	26	0.424759964	25
11	Indian Overseas Bank	0.50499504	17	0.509071114	21	0.505494576	20	0.491193382	21
12	Oriental Bank of Commerce	1	1	1	1	0.790733165	10	1	1
13	Punjab & Sind Bank	1	1	0.78510381	8	0.842417084	8	1	1
14	Punjab National Bank	0.427661508	21	0.479582579	23	0.491939203	21	0.414507772	26
15	Syndicate Bank	0.789369858	7	0.699142401	13	0.653549044	14	0.606159813	16
16	UCO Bank	0.377523393	25	0.592507262	15	0.594487627	17	0.612204769	15
17	Union Bank of India	0.492124823	18	0.4995313	22	0.505822332	19	0.548729292	19
18	United Bank of India	0.380205334	22	0.553046326	18	0.45707585	23	0.489095504	22
19	Vijaya Bank	0.642790071	12	0.734770162	10	0.77854801	11	0.841021931	10
20	State Bank of India (SBI)	0.378245614	24	0.413003626	25	0.434309623	25	0.51391863	20
21	State Bank of Bikaner & Jaipur	0.563863447	14	0.683179697	14	0.775124737	12	0.675868141	14
22	State Bank of Hyderabad	0.51901672	16	0.522520479	19	0.624515955	15	0.692623121	13
23	State Bank of Indore	1	1	1	1	1	1	1	1
24	State Bank of Mysore	0.969641357	5	1	1	1	1	1	1
25	State Bank of Patiala	0.660813175	10	0.781637029	9	0.987221167	7	1	1
26	State Bank of Saurashtra	0.919615636	6	1	1	1	1	1	1
27	State Bank of Travancore	0.571824491	13	0.704525604	11	0.751637048	13	0.780285443	12

Table A.11
DEA score and Ranks of Asset Quality of Private Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	Bharat Overseas Bank Ltd.	0.216222901	19	0.489733948	11	0.446010083	11	0.274464422	11
2	City Union Bank Ltd.	0.204744692	20	0.278117227	22	0.336805226	18	0.157935356	21
3	Development Credit Bank Ltd.	0.242328849	15	0.39363697	16	0.381985164	15	0.173868909	18
4	ING Vysya Bank Ltd.	0.116544512	29	0.636674401	5	0.703182283	6	0.351764276	9
5	Karnataka Bank Ltd.	0.18894599	23	0.283449634	21	0.329980308	19	0.107908426	29
6	Lord Krishna Bank Ltd.	0.217121368	18	0.276669179	23	0.421704884	12	0.27212169	12
7	The Nainital Bank Ltd.	1	1	1	1	1	1	1	1
8	SBI Coml. and Intl. Bank Ltd.	0.271963649	12	0.312621933	19	0.373314772	16	0.349309238	10
9	Tamilnad Mercantile Bank Ltd.	0.190426407	22	0.219563028	28	0.235393244	29	0.114508067	28
10	The Bank of Rajasthan Ltd.	0.121119867	28	0.199312999	29	0.248405992	28	0.145246163	24
11	The Catholic Syrian Bank Ltd.	0.133378478	27	0.255777172	26	0.269872506	25	0.146220158	23
12	The Dhanalakshmi Bank Ltd.	0.182079765	24	0.276667723	24	0.313923452	20	0.194253109	14
13	The Federal Bank Ltd.	0.143637881	26	0.235089294	27	0.287984311	22	0.164099612	20
14	The Ganesh Bank of Kurundwad Ltd.	1	1	1	1	1	1	1	1
15	The Jammu & Kashmir Bank Ltd.	0.274408635	11	0.57459565	7	0.891229258	4	0.389906221	6
16	The Karur Vysya Bank Ltd.	0.269025595	13	0.422111932	14	0.398622476	14	0.192956135	16
17	The Lakshmi Vilas Bank Ltd.	0.230700464	17	0.340093744	17	0.287952809	23	0.171665335	19
18	The Ratnakar Bank Ltd.	0.37226814	8	0.537947857	8	0.508185909	9	0.377594619	8
19	The Sangli Bank Ltd.	0.20059433	21	0.316298062	18	0.403120158	13	0.193724874	15
20	The South Indian Bank Ltd.	0.145953237	25	0.310481092	20	0.346243259	17	0.152485897	22
21	The United Western Bank Ltd.	0.258474487	14	0.259485838	25	0.258989336	26	0.119057069	26
22	Bank of Punjab Ltd.	0.471334041	7	0.752676037	4	0.612976571	8	0.177559022	17
23	Centurion Bank Ltd.	0.327475436	9	0.404038806	15	0.278481967	24	0.118434836	27
24	Global Trust Bank Ltd.	1	1	0.505038303	10	0.25387722	27	7.29E-02	30
25	HDFC Bank Ltd.	1	1	1	1	1	1	0.540540541	4
26	ICICI Bank Ltd.	0.599168602	6	0.521287318	9	0.311478572	21	0.137657539	25
27	IDBI Bank Ltd.	0.695809497	5	0.439130962	13	0.866761882	5	0.47866902	5
28	IndusInd Bank Ltd.	0.233139497	16	0.476049566	12	0.446285103	10	0.263933	13
30	UTI Bank Ltd.	0.29581147	10	0.617294482	6	0.622200278	7	1	1

Table A.12
DEA score and Ranks of Asset Quality of Foreign Banks

S.No	Name of the Bank	Score (1999-2000)	Rank	Score (2000-01)	Rank	Score (2001-02)	Rank	Score (2002-03)	Rank
1	ABN-Amro Bank N.V.	1	1	0.51102575	12	4.97E-02	27	9.76E-02	20
2	Abu Dhabi Commercial Bank Ltd	0.198173064	19	0.234249293	22	2.35E-02	31	3.05E-02	31
3	American Express Bank Ltd.	0.12414455	27	0.116252904	28	1.85E-02	32	0.021427732	32
5	Arab Bangladesh Bank Ltd.	0.778991296	7	0.944308125	9	0.712875169	7	0.454412155	9
6	Bank Internasional Indonesia	1	1	1	1	1	1	1	1
7	Bank Muscat SAOG	1	1	1	1	0.173242042	13	0.148733714	17
8	Bank of America NA	0.351738	14	1	1	6.33E-02	19	0.530852995	8
9	Bank of Bahrain and Kuwait BSC	0.134208227	26	0.192971802	25	6.93E-02	18	6.09E-02	26
10	Bank of Ceylon	0.356867554	13	0.427491171	15	0.405241789	9	0.22226218	14
11	Barclays Bank PLC	1	1	0.564310132	11	4.98E-02	26	1	1
12	BNP Paribas	1	1	0.693544016	10	5.12E-02	25	5.50E-02	28
13	Chinatrust Commercial Bank	0.442716184	11	1	1	1	1	1	1
14	Chohung Bank	0.679438574	8	1	1	0.400326507	10	0.44280351	10
15	Citibank N.A.	0.494309213	9	0.475443105	14	0.173669472	12	0.154966438	16
16	Credit Agricole Indosuez	0.102619208	29	0.211721852	24	5.49E-02	22	5.87E-02	27
17	Credit Lyonnais	0.151226543	24	0.279337124	20	4.37E-02	29	6.21E-02	25
18	Deutsche Bank AG	8.09E-02	31	0.307280504	16	5.38E-02	23	0.261044177	13
19	ING Bank	0.181418474	21	0.144552397	27	8.01E-02	17	1	1
22	MashreqBank psc	0.162492964	22	0.303851941	17	0.927580747	6	0.342890554	11
23	MIZUHO Corporate Bank Ltd.	0.213694239	17	9.00E-02	29	0.648032614	8	0.30990152	12
24	Oman Inlcrnational Hank SAOG	9.68E-02	30	1	1	0.100717062	16	8.05E-02	22
25	Oversea-Chinese Banking Corporation Ltd.	1	1	0.161111025	26	5.69E-02	20	1	1
26	Societe Generale	0.119135371	28	1	1	1	1	4.68E-02	29
27	Sonali Bank	0.447608427	10	0.237549958	21	0.208838189	11	1	1
28	Standard Chartered Bank	0.143027618	25	0.22974486	23	1	1	0.148552565	18
29	State Bank of Mauritius Ltd.	0.207754051	18	6.08E-02	30	4.91E-02	28	9.47E-02	21
30	Sumitomo Mitsui Banking Corporation	0.226832835	16	0.482758621	13	0.119138736	14	6.23E-02	24
31	The Bank of Nova Scotia	0.374385598	12	1	1	5.31E-02	24	3.64E-02	30
32	The Bank of Tokyo - Mitsubishi Ltd.	0.160192178	23	0.286688957	18	5.60E-02	21	1	1
34	The Hongkong & Shanghai Bkg.Corp.Ltd.	0.185081435	20	0.285634372	19	1	1	0.114485014	19
36	UFJ Bank Ltd.	0.242652763	15			0.030554701	30	7.15E-02	23
						0.109107676	15	0.195151493	15

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