CHAPTER III
REVIEW OF LITERATURE

3.0 Introduction:

In the foregoing chapter, an attempt has been made to trace the evolution of banking in India. As part of tracing the evolution, the roles of banking and financial sector reforms were also noted. Under the second phase of reforms, banks have been subjected to prudential norms and opened to competition among themselves. To face the stiff competition in a deregulated environment, banks should operate efficiently in respect of improving the profitability and / or reducing cost. Hence, to monitor banking activities, measurement of banking efficiency has been a crucial issue during the past one decade.

The focus of the present thesis has been on highlighting this issue in the Indian context.

Accordingly, this chapter aims at reviewing the previous work in this direction so as to provide the necessary background to the present study. Since the relevant literature, especially in the context of developed economies has been truly abundant, and given that a large part of the work has been carried out using parametric (stochastic frontier) and non-parametric (data envelopment analysis) approaches, the chapter is organised as follows: section 3.1 presents an overview of select studies during the past one decade outside India, using the stochastic frontier approach. This is followed by a similar review of studies which are based on equally popular non-parametric data envelopment analysis (DEA), in section 3.2. This is followed by an overview of the available studies in the Indian context, in section 3.3.
3.1 An overview of studies outside India – SFA:

Stochastic frontier analysis is a parametric approach to measuring the relative efficiency of banks. This technique has been popular in the literature. In this section we review select studies that were conducted in the recent past (past one decade) to highlight the various aspects of efficiency measurement.

We start with the study by Bikker (1999) who examined the efficiency in the European banking industry for the period 1989 to 1997. The stochastic cost frontier approach was used to estimate the x-efficiency of the European banks and a multi-product translog cost function to compare cost levels. The model had been applied to data pertaining to the nine European countries. The sample consists of all banking categories which included 3085 banks. The variables used were loans, demand deposits, savings and non interest income.

The study found that Spanish banks appeared to be the least efficient ones followed by banks in France and Italy, whereas Banks in Luxembourg were most efficient, followed by banks in Belgium and Switzerland. Banks in Germany, Netherlands and the United Kingdom took a medium position. Cost levels in Spanish banks were estimated to be 33% above the European average and X-inefficiency even 46%. Costs in Luxembourg were 34% below the European average and X-inefficiency 37%. The overall outcome indicated that differences in average cost levels and X-inefficiency between European Union countries were huge, the average inefficiency was most probably higher than the 20%, found often in the literature. The study suggested that in the countries where banks were less efficient, large scale consolidation and rationalization of the banking industry was necessary in order to improve its soundness.
Bonin, et al (2005) investigated the effects of ownership especially by a strategic foreign owner, on bank efficiency for eleven transition countries in an unbalanced panel consisting of 225 banks. Using SFA the study computed profit and cost efficiency taking account of both time and country effects directly for the period 1996-2000. The output variable were total deposits, total loans, total liquid assets and investments and the input prices were price of capital and price of funds. The paper observed that privatization alone was not sufficient to increase banks efficiency as government owned banks were not appreciably less efficient than domestic private banks. The study found that foreign owned banks in particular those with a strategic foreign owner collected more deposits and more loans than domestic private banks. The government owned banks made fewer loans, collected fewer deposits and had higher non interest expenditure than majority foreign owned banks. The participation of an international institutional investor had a considerable additional positive impact on profit efficiency.

The relative cost efficiency of a sample 289 banks in 15 east European countries using SFA for the years 1994-2001, was examined by Fries and Taci(2004). The paper found that the consolidation of smaller banks in the region would contribute to greater cost efficiency in banking. Greater macroeconomic stability and competition in banking from foreign entry as well as development of the supportive institutions promote cost efficiency. Banking systems with higher ratios of capital to total assets and banks with lower loan losses also tended to have lower costs.

The study found that privatized banks with majority foreign ownership were the most cost efficient, followed by newly established private banks, both domestic and foreign owned. Policies that many governments and central banks in Eastern Europe adopted to promote transformation of socialist banking systems into market oriented ones had, therefore, contributed to increased cost efficiency.
In the context of Pakistan, Kiani (2005) investigated empirically technical efficiency of commercial banks and also made efficiency comparisons between domestic and foreign banks. The paper employed the parametric techniques to study the nature and extent of cost inefficiency. Efficiency scores had been derived by implementing a parametric translog stochastic cost frontier on a balanced data of 18 banks from 1976-1996 operating in Pakistan. The study used the maximum likelihood estimating procedure to estimate parameters of the model. The maximum likelihood parameters estimates for the translog cost frontier for the year 1976-96 indicated a shift in respective cost structures of bank’s overtime.

The results showed that technological change occurred overtime for the Pakistani banks as well as the foreign banks. The results indicated that the domestic banks operating in Pakistan were relatively less efficient than their foreign counterparts. Ranking for the full sample indicated that the Deutsche Bank is relatively the most efficient bank, while the Punjab provincial bank for cooperatives was about 18% inefficient per annum as compared with its full potential, and thus regarded as the least efficient bank. The Deutsche bank was found to be most efficient having 97% efficiency levels and was ranked at number one, while the American national trust and savings Association was least efficient and was ranked at no.9. National Bank of Pakistan was relatively most efficient among the nine Pakistani banks while Punjab Provincial Bank for cooperatives was found to be least efficient. The study suggested that all Pakistani commercial banks need to improve their respective cost efficiency to bring them at an overall higher level. It also suggested that a more transparent market based system was needed which would improve intermediation efficiency reduce rent seeking activities, which helps in increasing the overall cost efficiency of banks without any political interference.
In the context of China’s banking sector over the period 1985-2002, Fu and Heffernan (2007) employed SFA to investigate cost X-efficiency. The objective was to assess whether different ownership types and banking reforms affect X-efficiency. The sample consists of four state owned and ten joint stock commercial banks. A two stage regression model was estimated to identify the significant variables influencing X-efficiency. The dependent variables used were total costs and the independent variables were total deposits, total loans, total investments, non-interest income.

The study found that the grand mean x-efficiency in China’s banking sector ranged between 40% and 50%. The joint stock banks were found to be relatively more x-efficient than the state banks, and the gap between them widening during the two reform stages. The paper observed that the x-efficiency in China’s banking sector could be improved if more state banks were converted to joint stock ownership, the dependence on purchased funds was reduced, greater cost control was encouraged, and hard budget constraints replace soft-ones.

For the Central and Eastern European Countries (CEEC) Rossi et al (2005) measured the managerial behaviour and cost/profit efficiency in the banking sectors. The study period covers the years 1995-2002 and the sample included 278 banks of nine selected CEECs, Czech Republic, Hungary, Poland etc. The study used SFA based on a Fourier flexible form to estimate efficiency. The study employed the modified production approach; price of labor, price of capital and price of deposits as inputs and loans, deposits and other earning assets as outputs.

The paper found that there was a low level of cost and profit efficiency for banks in CEECs. Conversely the results also revealed a significant tendency of efficiency (both cost and profit) to increase overtime, although this trend was not equally spread over all
countries. There were large and significant differences across countries and large gaps between cost and profit efficiency - banks in the former accession countries seem to be more efficient in controlling costs than in generating profits. Low cost efficiencies of banks were even often offset by high profit efficiencies and vice-versa. The study found that there was a negative correlation between cost efficiency and bad loans. It also observed that the exogeneity of bad loans was triggering inefficiency. High levels of problem loans, generated by external factors - such as environmental conditions, level of criminality etc – caused a decrease in the level of cost efficiency. The result indicated that the low level of efficiency recorded in the CEECs could therefore be partially ascribed to uncontrolled external factors. Bank inefficiency and failures in the markets were primarily associated with external shocks. The study suggests that regulatory and supervisory rules should therefore focus on reducing banks exposure to unforeseen events. This could for instance be done by increasing the diversification of loan portfolios - limits on loan concentration, promoting mergers with foreign institutions or an encouragement of banks towards a low risk profile by lowering the ratio between loan and total assets.

For ten Asian countries, Shen et al (2009) estimated the cost efficiency in banking industry during the period 1998-2005. An unbalanced panel data set contained 285 banks was taken. Intermediation approach was adopted. The outputs specified were total loans, other earning assets and non interest income; the input variables were price of funding or deposits, price of labor and price of fixed assets. Another important set of variables were the cross country environmental variables (i) those that describe the main macro economic conditions. (ii) Variable that describes the structure and regulation of the banking industry and (iii) accessibility of the banking service. The study compared the
cost efficiency scores estimated from the panel data SFA models with or without incorporating the cross country heterogeneous factors.

The study found that when heterogeneity was considered, the cost efficiency score was higher than when it was not included. Moreover India was found to be the most efficient among the ten Asian countries while China ranks only fourth as 20% less efficient which indicated that the Chinese banking industry was not so competitive against their neighbors and it had to deepen the financial reforms and improve the managerial ability. The study also found that higher density of population contributes to an increase in the costs of banks. Higher the inflation, higher the costs that banks might incur. Influence of unemployment was negative.

Papadopoulos (2008) used the flexible Fourier functional form and the stochastic cost frontier methodologies to estimates X-inefficiencies, scale economies and technical change for a sample of Finnish, Swedish, Danish and Norwegian banks between 1997-2003. The results indicated the inefficiencies range between 20 per cent and 29.3 per cent in all four national samples. Swedish banks were the least efficient (mean 0.2932) and Danish banks the most efficient (mean 0.2014) with Finnish and Norwegian banks in the middle (mean 0.2345 and 0.2428 resply). The finding suggest that inefficiency increases with bank size where largest sized banks were generally the least efficient and the smallest sized institutions were the most efficient.

The paper also concludes that with the passage of time efficiency increased across all four national banking markets. The results suggest that banks in all four markets are characterized by economies of scale. The strongest economies of scale were displayed by Danish and Norwegian banks. Typically, medium sized banks reported the strongest economies of scale and the largest and smallest banks weaker economies of scales. The
impact of technical change in reducing bank cost appeared to be systematically increasing with bank size.

Baig et al (2008) examined the technical efficiency of the Pakistan banking sector for the period of 1990 to 2005, using stochastic frontier production function. The study used intermediation approach using deposits, labor as inputs and advances as outputs. The findings were as follows. Estimates of technical efficiency indicated that state owned or public sector banks were less efficient than private owned banks and foreign banks. Foreign banks were most efficient in the banking sector when their performance was analyzed from the year 1992-2005. The results very clearly showed the effectiveness of the reform process carried out in financial sector especially in the banking industry. Although state owned banks had huge assets as compared to other banks in the industry yet they were less efficient. One reason might be the cost ineffectiveness and over burdening staff with comparatively less facilities. Another reason for the low technical efficiency score of state owned banks could also be attributed to their involvement in less productive hence very essential state financial and social activities like pensioners accounts etc.

For Zambia, Musonda (2008) evaluated cost efficiency of banks using the SFA, by incorporating banks specific and environmental (including regulatory) factors in the analysis. The period of study was 1998-2004. The author adopted intermediation approach. The inputs chosen were labor, funds and capital; the outputs were sum of net loans, overdraft and inter bank placements, and investments in government securities.

The results showed that Zambian banks were on average inefficient. The study observed that there had been some improvement in the relative cost efficiency of banks, with small banks displaying spectacular growth in performance. The efficiency gap between
domestic banks and foreign banks remained wide. The study found that large banks appeared to adapt to technological change compared to the small banks. Regulatory intensity has not adversely impacted banks performance. On the other hand macro economic uncertainty particularly in the early years of this sample period exacerbated the banks cost inefficiency. These factors suggested that there should be stronger policy responses to overcome the structural impediments which continue to effect banks cost performance. On the other hand macroeconomic uncertainty particularly in the early years of this sample period exacerbated the inefficiency. These factors suggested that there should be stronger responses to overcome the structural impediments which continue to effect bank cost performance.

For 10 sub Saharan African middle income countries, Chen (2009) estimated cost efficiency using Stochastic Frontier Analysis. The cost function was estimated using deposits, other borrowed funds, labor and fixed capital as inputs and various types of loans and other earning assets such as securities, investments and total deposits as output. The study concluded that banks were operating at 20-30 per cent below the cost efficiency frontier, and that foreign banks on an average were more efficient than private banks and government owned banks. He also found that a stable macro environment, deeper financial development, higher degrees of market competition, stronger institutions and better governance would help improve the bank efficiency levels.

In a similar study, Neube (2009) analyzed the cost and profit efficiencies of eight (8) South African commercial banks. The study period was 2000-2005. Stochastic frontier approach was used and intermediation approach adopted. The inputs used were labor, capital and funds, and the outputs were advances and deposits.
Cost efficiency was found to have significantly improved over time, while the change in private efficiency levels was not significant. The small banks recorded higher average profit efficiency levels than the big banks, but these differences were found to be statistically insignificant. A weak positive correlation was found to exist between the cost and profit efficiencies with the most cost efficient banks also being most profit efficient. With regard to bank size, cost efficiency declined with increasing bank size.

In another study for a group of 29 Sub-Saharan African countries, Kiyota (2009) analyses the efficiency and profitability of commercial banks during 2000-2007. The paper analyses the efficiency and profitability of commercial banks by each group such as domestic bank, Sub-Sahara African foreign bank, or non SSA foreign bank. The study employed SFA to measure banks cost and profit efficiency. Using regression analysis the paper discussed the correlation of technical efficiency with the financial indicators. The dependant variables were cost efficiency and profit efficiency. Independent variables used were financial indicators such as asset quality, capital ratios, operational and liquidity ratios etc.

The study found that the profit efficiency of non-SSA foreign banks had a negative and statistically significant relationship with three variables namely, return on average equity (ROAE), equity to net loans and net loans to total assets during the pre crisis period (2004-2007). The position and statistically significant relationship with interest rate spreads was observed in the same period where as the signs of the both relationships were opposite for the 2000-2003 with statistical significance. These results implied that the African banking sector might be exposed to contagion risks. There might be contagion risks from distressed foreign parent banks to local subsidiaries within Sub-Saharan Africa because parent banks could withdraw capital from African subsidiaries, call in loans to
their African subsidiaries, no longer invest local profits in local subsidiaries, or did a combination of these.

Pasiouras et al (2009) examined the impact of banking regulations on banks cost and profit efficiency across various countries. The paper used SFA to provide international evidence on the impact of the regulatory and supervision framework on bank efficiency. Their sample consisted of a panel data set of 2853 observations from 615 publicly listed commercial banks operating in 74 countries, covering the period 2000-2004. The paper focused on banking regulations related to the three pillars of Basel-II (capital requirements, official supervisory power and market discipline) and restrictions on bank activities on cost and profit efficiency. The study compared banks cost and profit efficiency levels and simultaneously investigated their response to cross country differences in banking regulations, while controlling for country level environmental characteristics such as market structure, financial and overall economic development and macro economic conditions. The study used value added approach, the outputs were loans, other earning assets and total deposits; the input prices were cost of borrowed funds, cost of physical capital and cost of labor.

The full sample overall mean cost efficiency score was 0.8789 while that of profit efficiency was 0.7679. Over the estimated period, banks had become, on average, more profit efficient but less cost efficient, since the efficiency scores for cost decreased each successive year from 0.8899 in 2000 to 0.8685 in 2004, while those for profit increased from 0.7592 to 0.7842 over the same period. The results indicated that (i) stricter capital regime requirements, related to the first pillar of Basel I, had a positive impact on cost efficiency but a negative impact on profit efficiency. (ii) official disciplinary power and market discipline had a statistically significant and negative impact on both cost and
profit inefficiency. (iii) with regard to restrictions on bank activities, a negative effect on cost efficiency and a positive effect on profit efficiency was observed.

For the Greek commercial banks from 1993 to 2008, Delis et al (2009) evaluated the cost and profit efficiency, and also compared the cost efficiency measures obtained from parametric and non-parametric approaches. They argued that a comprehensive approach to bank efficiency measurement required a cross checking between the different available techniques. To perform this task the study proceeded in two stages. First, it analyzed both cost and alternative profit efficiency of the Greek banking system over the period 1993-2005 using the SFA. Translog cost and profit functions were estimated following the intermediation approach. Secondly, the study analyzed the effect of size and of the ownership status on the cost and profit measures of efficiency. They compared the results of the SFA with those obtained by a variant of non-parametric approach viz: VRS-DEA. The paper adopted the intermediation approach and specified the following inputs and outputs—Labor and borrowed funds were the input variables and other earning assets were the outputs.

They found lower levels of cost efficiency than profit efficiency; both measures reflected an improving trend over the sample period. The difference between the levels of cost and profit efficiency was quite significant. Large sized banks were found more cost efficient than their smaller counterparts, while an opposite result was established under profit efficiency. Furthermore, the state owned banks emerged as more cost efficient, while at the same time they were less profit efficient. The results of the DEA exercised revealed higher average inefficiency than those of the SFA. In fact the average programming inefficiency scores almost doubled compared to those of the SFA. Furthermore, inefficiency scores derived from the stochastic and programming frontiers appear to have gradually declined over the sample period, indicating a significant positive correlation
between the yearly average scores of the two approaches. Both methods indicated that cost efficiency was positively related to bank size, while the findings regarding the effect of ownership status were contradictory between the two approaches. The results obtained from the various methods were substantially different. This might be attributed to the inner advantages and disadvantages of each approach and hence, it is important to use more than one methodology to evaluate bank inefficiency.

In yet another study for the sub Saharan African Countries, Kablan (2010) estimated the level of banking efficiency and the factors determining it for the periods 2000-2004. The paper also sought to explain the level of financial development in Sub-Saharan Africa (SSA). The sample consisted of 137 banks in 29 African countries. The study used SFA to measure cost efficiency in SSA. The followed the intermediation approach and value added principle. The outputs were deposits, loans and securities and the inputs were labor, physical capital and financial capital.

The results showed that generally banks in SSA countries were cost efficient. The cost efficiency score of SSA banks was 0.76 suggesting that the banks were 76% efficient. The study found that capitalization and NPLs had a negative impact on efficiency, per capita GDP had a very small but significant negative impact. The density of the rural population had a negative impact on cost efficiency of SSA by banks. The study also found that financial development was adversely effected by inflation and concentration i.e. dominance of the system by a few banks.

3.2 An Overview Studies outside India – DEA

Data envelopment analysis is a non-parametric technique which has been employed for measuring banking efficiency. In this section, a few important studies are reviewed.
Barr et al. (1999) estimated the productive efficiency of banks using a constrained multiplier, input oriented, data envelopment analysis model from 1984 to 1998. The inputs used in the study were salary expenses, premises and fixed assets, other non-interest expense, interest expense and purchased funds. The outputs were earning assets, interest income and non-interest income. The study found that there was a strong and consistent relationship between efficiency scores and the inputs and outputs, as well as independent measures of bank performance. Non-interest income, other non-interest income and purchased funds were inversely related efficiency and earning assets and return on average assets were positively related to efficiency. The study found that only return on average assets, the ratio of non-performing loans to gross loans and the relative level of purchased funds seemed to be impacted by improved economic conditions. Institutions rated by examiners as the strongest had higher efficiency scores than those institutions rated as the weakest in each year of the study.

For a sample of Turkish commercial banks, Jackson and Fethi (2000) estimated the technical efficiency. The technical efficiency was derived for a cross section of forty eight (48) Turkish commercial banks in the year 1998. The efficiency was evaluated using the non-parametric frontier methodology, the DEA. This analysis was repeated under different scale assumptions. To investigate the determinants of efficiency Tobit model was used. After obtaining the efficiency measures, they implemented censored regression analysis (using Tobit model) to explain the variations in calculated efficiencies to a set of explanatory variables. These variables were bank size, profitability, capital adequacy ratio, number of branches and ownership. The study had usable data for 48 commercial banks for the year ‘1998. This study adopts Griffel-Tatje and Lovell’s (1997) value added approach to specify the inputs and outputs. The number of employees and
the sum of non labor operating expenses, direct expenditure on buildings and amortizations expenses were specified as the two inputs, whereas the outputs were loans, demand deposits and time deposits.

In the initial analysis of 48 banks based on two inputs and three outputs amounts to 0.67, indicating that on average, banks could produce outputs with approximately 33% fewer inputs. (The efficiency scores ranged from 14% to 100% when CRS was assumed). The paper concludes that both bank size and profitability have significant positive effect on efficiency, indicating that the larger and more profitable banks had higher technical efficiency. On the other hand the capital adequacy was significantly negatively related to the technical efficiency. The number of branches yields a negative and insignificant coefficient. The paper concludes that the negative coefficient of the State ownership variable confirms that the State ownership worsens efficiency.

Jemric and Vujcic (2002) analyzed bank efficiency in Croatia between 1995-2000 using DEA. Different sets of inputs and outputs were used for the two approaches i.e. operating approach and intermediation approach. For the operating approach the inputs used were interest and related costs, commissions for services and related costs, labor related administrate cost and capital related administrative cost and the outputs were interest and related revenues, non-interest revenues. For the intermediation approach fixed assets and software, number of employees and the total deposits received were used as inputs. Total loans extended and short term securities were used as outputs.

The paper found that the foreign-owned banks were on average the most efficient and the new banks were more efficient than the old loans and in terms of size, the smaller banks were globally efficient, while larger banks were locally efficient. The paper found that the most significant cause of inefficiency among State-owned and old banks versus
foreign-owned and new ones was the number of employees and fixed assets. The results also showed that the technically more efficient banks had less non-performing loans.

For the Spanish banking sector, Maudos and Pastor (2003) estimated the cost and profit efficiency. They estimated the cost and profit efficiencies of commercial and saving banks for the period 1985-1996. The paper adopted non-parametric DEA methodology to estimate the efficiency. The authors adopted the intermediation approach and specified following variable as inputs and outputs. The inputs used were loanable funds, number of employees and physical capital. The outputs used were profitable assets and securities portfolio.

The paper found that the cost efficiency of savings banks and commercial banks was 80.20% and 90.90% respectively which was higher than the levels of profit efficiency. The paper also found that the standard profit efficiency levels of the commercial banks (66.5%) were higher than those of the saving banks (47.2%) to such an extent that the minimum difference occurs in the last year of the sample. In the case of the alternative profit efficiency the commercial banks enjoyed higher levels of efficiency 52.9% as against the savings banks 34.7%. The paper observed that levels of standard profit efficiency being higher than alternative profit efficiency implied the existence of market power in the setting of prices.

In a comparative study concerning India and Pakistan, Ataullah et al (2004) attempted a comparative analysis of the evolution of the technical efficiency of the banking industry for the period 1988-1998. Data envelopment analysis was applied to two alternative input output specifications to measure technical efficiency and to decompose technical efficiency into two components, pure technical efficiency and scale efficiency. The first model postulated operating and interest expenses as inputs, and loans and advances and
investments as outputs. The second model postulated operating and interest expenses as inputs and interest and non-interest income as outputs.

It was found that the overall technical efficiency of the banking industry improved following the financial liberalization, especially after 1995-96. In the case of India, efficiency increased due to improvement in both pure technical efficiency and scale efficiency. In Pakistan, the increase in overall technical efficiency was due to an improvement in scale efficiency. The results suggested that the efficiency of commercial banks was much higher in the first model which used earning assets as outputs, than in the second model, which used income as output. The paper observed that the gap in efficiency scores obtained from the two models could be due to the presence of high non-performing loans in the asset portfolios of banks in the two countries. The results also suggested that implementation of financial liberalization closed the efficiency gap between large and small banks. The results also suggested that there was still room for improvement in the efficiency of bank in both the countries.

Similarly, Hauner (2004) estimated cost efficiency, scale efficiency and productivity change using date envelopment analysis for the period 1995-99. The sample covers all German and Austrian commercial banks whose total assets exceeded five billion dollars at the end of 1999. Intermediation approach was used. The inputs used were banks aggregate funds and labor. The outputs were loans, fixed income and securities.

The study concluded that the average cost efficiency score of German Austrian Banks over the years 1995-99 was 0.63, i.e., the sample banks could have produced the same output quantities with only 63 per cent of the observed cost. The study found a slight deterioration in cost efficiency over the second half of the 1990s. The decomposition of cost efficiency into technical and allocative efficiency suggested that cost inefficiency
was mostly due to the use of wrong inputs at the prevailing input prices, rather than waste of inputs. On average, technical efficiency amounted to 0.94 and allocative efficiency to 0.66. Technical efficiency and allocative efficiency remained on average virtually unchanged over the five years observed. It was found that Austrian banks were less cost efficient than German Banks. No significant differences between the cost efficiency of privately owned banks and cooperative banks were found. Independent (i.e., not state owned) saving banks were found to be significantly cost efficient. State owned banks were found to be more cost efficient than other banks.

Chen et al (2005) examined the cost, technical and allocative efficiency of 43 Chinese Banks over the period 1993-2000 using DEA. The paper attempts to identify the change in Chinese bank efficiency due to deregulation initiated in 1995. The study uses interest expenses, non-interest expenses, price of deposit and the price of capital as inputs and loans, deposits and non-interest income as outputs. The paper found that the financial deregulation of 1995 improved cost efficiency levels including both technical and allocative efficiency. The technical efficiency dominated the allocative efficiency of Chinese banks. Results showed that the large State owned banks and smaller banks are most efficient than medium sized Chinese banks.

Hauner and Peiris (2005) analysed the impact of banking sector reforms undertaken in Uganda to improve competition and efficiency using DEA. The paper found that the level of competition has increased significantly and had been associated with a rise in efficiency. The paper adopted the intermediation approach to estimate efficiency with deposits, loans and contingent liabilities as inputs and deposit holdings, securities and loans as outputs. It has been found that on an average, larger banks and foreign owned banks have become more efficient, while smaller banks have become less efficient in the face of increased competitive pressures.
Jen-Li Hu et al (2006) analyzed the efficiency of 12 Chinese banks using the DEA for the period of 1996-2003. The input variable included in the study was savings, number of employees and the net fixed assets and the outputs were investments and lending.

First, the DEA approach was used to estimate the efficiency scores then the Tobit regression was used to analyze how the environmental variable affect the efficiency scores of banks. The study found that: (i) Nationwide joint equity commercial banks had significantly higher over all technical and scale efficiency but lower pure technical efficiency than State owned specialized banks. (ii) The marginal increasing relation existed between deposit loan ratio and allocative efficiency. (iii) Small sized banks had higher cost, allocative over all technical and pure technical efficiencies than large sized banks. (iv) The banks had lower costs, over all technical, pure technical, and scale efficiency after the 2001 WTO participation. (v) The banks had lower cost efficiency after the 1997 Asian financial crisis. (vi) The banks in China had significantly increasing over all technical and scale efficiencies from 1996-20003.

Ariff and Can (2008) investigated the cost of profit efficiency of 28 Chinese commercial banks for the period 1995-2004. They examined influence of ownership type, size, risk profile, profitability and key environmental changes on the bank efficiency using a Tobit regression. The intermediation approach was used. They used three inputs—total loanable funds, number of employees and physical capital and their prices. Two outputs namely total loans and investments and their prices were considered.

The study found that the profit efficiency levels of the banks analyzed were well below those of cost efficiency, and alternative profit efficiency levels lower than those of standard profit efficiency. Joint stock commercial banks on average were more cost and profit efficient than state owned commercial banks. Taking all banks together while
standard profit efficiency had remarkably increased, cost efficiency and alternative profit efficiency had not improved over the period analyzed. The coefficient on state ownership was negative and significant at 1% in terms of alternative profit efficiency. Medium sized banks were most efficient. The paper observed that banks which had a higher ratio of loans to assets tended to incur higher credit risk and thus higher loan loss provisions, and were less efficient. More profitable banks with a focus on fees based activities tended to be more efficient. The results suggested, speedier reforms to open the banking market, diversifying ownership, minimizing the Government’s capital subsidy, and enhancing asset quality control to improve bank efficiency of Chinese banks.

Kablan (2007) measured WAEMU (West African Economic Monetary Union) banks efficiency and its determining factors after the banking sector reforms from 1993-1996 using DEA to estimate technical efficiency and SFA for cost efficiency for 35 banks. The study period was from 1999 to 20004. The study used labor, physical capital, and financial capital as inputs and loans, deposits, securities as outputs.

The estimated scores of efficiency of WAEMU banks were around 0.67 for cost efficiency and 0.76 and 0.85 for technical efficiency under CRS and VRS respectively. The paper concluded that efficiency level increased during the study period apart from Ivory Coast, Burkina Faso. The paper found that the local banks with private capital were the most efficient ones followed by foreign banks subsidiaries and State owned banks which displayed the lowest cost and technical efficiency scores. The paper also found that even the import of new technologies did not contributed to the improvement of technical efficiency.

For the Bulgarian banks, Nenovský et al (2007) estimated efficiency of the banking system. The study covered the period of 1999-2006. They used standard indicators for
bank efficiency, namely, return on assets, return on capital, operating profit, net interest income, non-interest expenditures and exchange rate revaluations. DEA approach was used to estimate banks efficiency scores. Operating approach and intermediation approach had been used to estimate efficiency. For the operating approach they used two variables for inputs- interest and related cost and non-interest costs, while for the outputs they took interest and related revenues and non-interest revenues. For the intermediation approach the production factors used were the fixed assets, the no. of employed and the deposits while the final products were covered by loans and securities.

The study concluded that under the operating approach to DEA they observed a tendency of increase in average efficiency of the banking system, which was interrupted in the last year of the analyzed period. Intermediation and operating approaches to DEA showed that there was equalization in the Bulgarian banking system during the analyzed period. The foreign banks had relatively higher efficiency as compared to the domestic and State owned banks, as a result of the transfer of knowledge, better management practice, including administrative cost optimization.

Staub (2010) estimated cost, technical and allocative efficiencies for the Brazilian banking system (2000-2007) using cost data and data envelopment analysis. The sample includes an unbalanced panel data of 127 banks. They followed the intermediation approach and employed capital, labor as inputs and investments, total loans, net of provision loans and deposits as outputs. The results showed that the average allocative and technical efficiencies were about 66.9% and 63.3% respectively. Allocative efficiency was always greater than technical efficiency for the period from June 2000 to December 2002. In the later period, beginning in June 2003 allocative efficiency falls and was below technical efficiency by the end of 2006 and 2007. During the period 2000-2007 allocative inefficiency has increased. This might have been due to fluctuations and
instability in factor prices. It was found that foreign banks were less cost efficient than their domestic counterparts. State owned banks were more efficient than private banks. Banks with foreign participation and foreign banks were the least economic efficient.

Rehman and Raoof (2010) investigated the overall efficiency scores of Pakistani banking sector over the period of 199-2007 using DEA. The inputs used in this study were deposits and net capital. The outputs were loans and advances and investments. The results showed an inconsistent performance of banking sector. In 1998 all banks performed well which was evident from their high efficiency scores. But after this the performance became inconsistent. In 1999 and 2001 banking sector efficiency scores were very low as compared to the world standard. The study concludes that due to high rate measures and acquisitions in banking sector during 2006-2007, the performance of public sector banks was significantly different from private and foreign banks in terms of technical efficiency. The performance of private and foreign banks declined.

3.3 Indian Studies:

The issue of measuring performance of banks has been the prime concern of regulators as well as economists since the early 1970s. Starting with the Luther Committee (1977) several official committees as well as research studies have highlighted this issue. The PEP (1977) Committee proposed a system of assessment of relative performance of banks in respect of four dimensions namely, productivity, social objectives (spatial), social objectives (sectoral), and profitability. The committee in all proposed 19 indicators for monitoring bank performance. The Ministry of Finance, Government of India, also made use of similar indicators during 1985-86. The Pendharkar Working Group (1982-83) also emphasized the need for evolving a system of evaluation and rating of banks. The Group had identified certain parameters. The Chakravarty Committee (1985) also expressed

In this sub-section an attempt is made to review select studies in the Indian context to serve as background to the empirical work of this thesis.

Starting with the study by Rangarajan and Mampilly (1972), several researchers had contributed towards analyzing the productivity growth of banks. Shetty (1979) critically examined the extent to which banking system in India had been able to achieve the objectives set before it initially by the scheme of “social control” over commercial banks introduced in 1968 and subsequently by the nationalization of major Indian banks. The study analyzed the performance of commercial banks during the post-nationalization period i.e. 1969-78 in regard to branches, deposits and credit etc. of the banks.

Focusing on profits of Indian commercial banks, Angadi (1986) two denominators namely, working funds and current operating earnings, and concluded that the significant factors affecting profitability of the banks were outside the policy constraints or exogenous factors namely, the earnings and the expenses of the banks. The rise in expenses responsiveness was followed by the rise in the earnings but the rate of increase of the former was much higher than in the later. Similarly fall in the expenses responsiveness was followed by the fall in the responsiveness of earnings. However, the fall in the former was much less than the fall in the latter. This trend in responsiveness of earnings and expenses explained the deteriorating situation of the banks during 1963-1982.
There are other studies which analyzed the banking performance issue (see. Tyagarajan (1975), Karkal (1983), Agarwal (1991), Subrahmanyam (1993), Subrahmanyam and Swamy (1994)). These studies however failed to link growth performance to regulatory events, and also to examine the efficiency of banking service as such. Further there are more studies in the literature that took a broader view of the performance of the banking sector and attempted to examine efficiency.

Adopting the methodology of principal components, Hansda (1995) attempted to identify the strategic variables that influenced the performance variability of public sector banks during the period 1991-94. The performance of banks was sought to be judged on the basis of productivity, financial management, profitability and sustainability. The study found that there was no relative change in the position of 18 of 28 public sector banks during the study period.

It may however be noted that studies upto this point of time mainly used methods such as ratio analysis, regression analysis, index numbers, multivariate analysis. In the subsequent periods, quite a few studies have adopted the modeling approach to examine the efficiency of banks using the parametric as well as non parametric DEA models.

Using the DEA, Bhattacharyya et.al (1997) examined the impact of the limited liberalisation initiated before the deregulation of the 1990s on the performance of various categories of banks. The study covered in all 70 banks during the period 1986-91. The study used advances, investments and deposits as outputs and interest expense and operating expense as inputs and constructed one grand frontier for the entire period and measured the technical efficiency of the banks under study. It was found that public sector banks had the highest efficiency among the three categories, with foreign and private banks having much lower efficiencies. It was also noted that, public
sector banks started showing a decline in efficiency after 1987, private banks showed no change and foreign banks showed a sharp rise in efficiency.

Das (1997) examined overall efficiency technical, allocative and scale - at PSBs for the period 1990-96. A non-parametric programming approach was used to calculate the overall, technical, allocative, pure technical and scale efficiencies of PSBs. The study found that there was a decline in overall efficiency which was attributed to the decline in technical efficiency, both pure and scale, which was not offset by an improvement in allocative efficiency. The study, however, also pointed out that the deterioration in technical efficiency was mainly on account of four nationalised banks. In a similar study, Sarkar and Das (1997) compared performance of public, private and foreign banks for 1994-95 by using measures of profitability, productivity and financial management and reiterated the conclusion that the public sector banks performed poorly relative to the other two categories.

Sarkar et al (1998) compared the performance of banks using two measures of profitability namely, return on assets and operating profit ratio, and four efficiency measures namely, net interest margin, operating profit to staff expense, operating cost ratio and staff expense ratio (all ratios except operating profit to staff expense having average total assets in the denominator) across the three categories of banks - public, private and foreign - in India. The authors had made these comparisons after controlling for a variety of non-ownership factors that might have an impact on performance: asset size. These factors were: proportion of investment in government securities, the proportion of directed credit, the proportion of rural and semi-urban branches, and the proportion of non-interest income to total income.
The study found that between private banks and PSBs, there was only a weak ownership effect. Traded private banks were found to be superior to PSBs with respect to profitability measures but not with respect to efficiency measures. Non-traded private banks did not significantly differ from PSBs in respect of either profitability or efficiency. There was, however, a strong ownership effect between foreign banks and private banks, with the former outperforming the latter with respect to all indicators. The study concluded that private enterprises might not be unambiguously superior to public enterprises in a developing economy. The study ascribed the particular ordering of performance that they found foreign, traded private, non traded private and public - to the link between performance and the market for corporate control. The stronger the link, better the performance.

In a related study Sarkar et al (1998) examined the ownership-performance issue by estimating the Analysis of Covariance model for two profitability performance measure namely, Return on Assets (RoA) and Operating Profit Ratio (OPR), and four efficiency performance measure namely, Net Interest Margin (NIM), Operating Profit to Staff Expense (OPSE), Operating Cost Ratio (OCR) and Staff Expense Ratio (SER) by pooling data for two years, 1993–1994 and 1994–1995 on 27 public banks, 23 domestic private banks, and 23 foreign banks.

The study concluded that traded private banks were superior to public banks with regard to both return on assets and income earning potential and private banks as a group (including non-traded banks) were significantly superior with respect to the return on assets. The study noted that neither traded nor non-traded private banks seemed to have any comparative advantage with respect to the operational efficiency parameters. Foreign banks were found more profitable and efficient than traded private banks that were more profitable than non-traded private banks. Non-traded banks, however, were not found to
have any significant differences in performance, either with respect to profitability or efficiency vis-a-vis the public sector banks. The study suggested that there existed only a weak ownership effect of private banks over public banks in India.

In another study, Das (1999) compared the performance of public sector banks for three years in the post-reform period: 1992, 1995 and 1998. He found that there was certain convergence in performance and also noted that while there was an increase in emphasis on non-interest income, banks had tended to show risk-averse behaviour by opting for risk-free investments over risky loans.

The study by Srivastava (1999) examined whether: (i) bigger banks are better for India and (ii) to what extent has the domestic impetus of financial sector reforms made banking more efficient. The study period was 1995-96 and included all schedule commercial banks in India save RRB’s. This paper analyzed the cost structure in Indian banking using stochastic frontier approach (SFA) and found that most, if not all, Indian banks were operating at scales below the optimal size. Banks with a larger size were found to be more cost efficient.

The first major study employing DEA to analyse the issue of banking efficiency in India was conducted by Saha and Ravisankar (2000). Emphasizing the need to measure efficiency of public sector banks keeping in mind the interests of regulators as well as investors, the study was undertaken during the period 1991-92 to 1994-95. Four inputs and eight outputs were selected for the DEA analysis. The inputs were: no of bank branches, staff (no of employees), establishment expenditure and non-establishment expenditure. The outputs were: deposits, advances, investments, spread, and total income, interest income, non-interest income and working funds. The study came out with the conclusion that barring few exceptions, the public sector banks in general improved their
efficiency scores over the years 1992 to 1995. This finding was consistent with the market perceptions of the banks.

In a similar study, Sathye (2003) estimated the productive efficiency of different groups of Indian banks i.e. PSBs, private and foreign banks. The sample consists of 27 public sector commercial banks, 33 private sector commercial bank and 34 foreign banks. The sample period was 1997-98. The efficiency measures were obtained using variable returns to scale (VRS) input oriented model of the DEA methodology.

Two models had been constructed to show how efficiency scores varied with the change in inputs and outputs. In the first model interest expenses, non-interest expenses were used as inputs and net interest income and non-interest income were used as outputs. In the second model the inputs were deposits and staff and outputs were net loans and non-interest income. The study showed that in the first model the public sector banks had a higher mean efficiency score as compared to the private sector and foreign commercial banks in India. As per second model, they had lower mean efficiency score than the foreign banks but still higher than private sector commercial banks. Most banks on the frontier were foreign owned.

Ram Mohan (2002) evaluated the performance of Public sector banks (PSBs) since deregulation in absolute and relative terms using financial measures of performance relating to the period 1994-95 to 1999-2000. The study used indicators viz., net profits, net interest margin, intermediation cost and non-performing assets. The study found that PSBs have improved their performance in both absolute and relative terms and noted that there was a trend towards convergence in performance between public and private sector banks.
Using a generalized shadow cost function approach, Kumbhakar and Sarkar (2003) analyzed the relationship between deregulation and total factor productivity (TFP) the growth of which was decomposed into a technological change, a scale, and a miscellaneous component. The study adopted a disaggregated panel data analysis, using the population of public and private banks over 1985-96 that covering both pre- and post-deregulation periods. The study found that while private sector banks improved their performance on account of the freedom to expand output, public sector banks did not respond well to the deregulation measures.

In another study, Ram Mohan (2003) evaluated the performance of public sector banks (PSBs) consequent to disinvestment by examining the long-term returns to the stocks of public and private sector banks in India. Comparing with returns to the Sensex both on an unadjusted as well as risk-adjusted basis, the study estimated the holding period returns for a total of 24 banks - nine PSBs, eight old private sector banks and seven new private sector bank. The study concluded that a mean nominal return of PSBs was superior to that of the Sensex over the corresponding period. On a risk-adjusted basis, they delivered a lower return with respect to the Sensex. Though in neither case was the difference in performance with respect to the Sensex statistically significant.

Ram Mohan (2004) compared the performance of three categories of banks - public, private and foreign using physical quantities of inputs and outputs, and comparing the revenue maximization efficiency of banks during 1992-2000. The study had adopted the DEA approach for the revenue maximization efficiency instead of profit efficiency. The author found that PSBs performed significantly better than private sector banks but no differently from foreign banks. Further the study concluded that
there was a convergence in performance between public and private sector banks in the post-reform era.

Bhaumik and Dimova (2004) examined the impact of ownership and competition on bank performance from 1995 to 2001 in India. The performance of a bank was determined by the size of the bank’s assets (ASSET), its priority sector advances as a percent of total advances (PRIORITY), investment in government securities as a percent of total investment (GOVSEC), non-interest income as a percent of total income (NONINT), non-urban branches as a percent of total branches (NONURBAN), ownership, a time trend (TIME), and interactions between the time trend and ownership dummies. The study considered four different types of Indian banks namely, public-sector banks (PUBLIC), old or incumbent private-sector banks (OLDPRIV), de novo or new private-sector banks (NEWPRIV), and foreign banks (FOREIGN). Further the study included quadratic form of assets of bank in the model considering the diseconomies scale if bank is too large.

The study found that private-sector and foreign banks were better performing, and hence more efficient, than public-sector banks initially. However, competition forced public-sector banks to eliminate this performance gap by the financial year 1998–1999. After 1998–1999, neither ownership nor competition per se affected bank performance significantly. Furthermore, capital market discipline had no influence on the performance of banks during the entire time period.

Jaffery et al (2007) measured changes in productivity and technical efficiency levels within banking sectors of the Indian sub-continent: specifically India, Pakistan and Bangladesh, over the period 1993–2001. A Malmquist index of total factor productivity (TFP) change over the time period in question was employed, along with a Tobit
regression, in order to determine whether these measures of regulatory and financial reform has had the desired effect upon the Indian sub-continent in terms of productivity and efficiency levels. It is found that technical efficiency both increased and converged across the Indian sub-continent in response to reform. India and Bangladesh experienced immediate and sustained growth in technical efficiency, whereas Pakistan endured a reduction in efficiency during the middle years of the study, before rebounding to levels comparable to the rest of the sub-continent in the latter years of the study. Results indicated that the measures employed to modernize the financial sectors of these respective countries had the desire effects upon levels of technical efficiency.

Ghosh et al. (2008) wanted to check whether market liberalization leads to decline in the cost of capital for domestic firms. Stulz (1999a,b) had identified two primary reasons for the decline in the potential for reduced systematic risk resulting from better diversification of risk and the potential for lower agency costs resulting from alignment of manager and shareholder interests. The study examined agency cost theory of the recent liberalization of foreign investment limits on Indian banks using event study analysis. They had found the result in favour of Stulz’s (1999a, b) hypothesis.

Bhaumik and Piesse (2008) examined banks’ behavior in the context of credit markets of India. They used dynamic panel model and estimated portfolio choice model for bank-level data for 9years (1995–96 to 2003–04). The study indicated that, in India, the data for the domestic banks fitted well the portfolio-choice model, especially for private banks, but the model did not explain the behaviour of foreign banks. In general, allocation of assets between risk-free government securities and risky credit is affected by past allocation patterns, stock exchange listing (for private banks), risk averseness of banks, regulations regarding treatment of NPA, and ability of banks to recover doubtful credit. It
was also evident that banks dealt with changing levels of systematic risk by altering the ratio of securitized to non-securitized credit.

In a straightforward application of the SFA on panel data, Shanmugam and Das (2004) measured technical efficiency of banks in four different ownership groups in India during the reform period 1992-99. The data set was an unbalanced panel of 94 banks belonging to four different ownership groups. The outputs were net interest margin, non-interest income, credits and investments. The inputs were deposits, borrowings, labor and fixed assets.

The results indicated the dominance of deposits in producing all outputs. The paper found that the observed outputs less than their respective potential outputs due to technical inefficiency of banks. The technical efficiency of raising interest margin was varied widely across sample banks and was time invariant. The banking industry showed a progress in terms of efficiency of banks raising non-interest income, investments and credits. The efficiency improvement was considerable in the case of investments in all banks, particularly in private banks. The study also found that the State Bank Group and foreign banks were more efficient than their counterparts.

The competitiveness of Indian commercial banks in a deregulated environment was examined by Amarender Reddy (2004) for the deregulated period 1996-2002. The data used for this study has been collected from annual reports of Reserve Bank of India. Efficiency change, scale efficiency and pure technical efficiency change between two periods has been estimated by using data envelopment analysis.

The results showed that there was an increase in technical efficiency and scale efficiency of most of the banks. The year to year variation in technical efficiency explained by variation in scale efficiency and general economic environment rather than variation in
pure technical efficiency. Most of the banks faced decreasing returns to scale especially public sector banks due to white spread bank branches with little inter-connectivity. The foreign banks and new private banks exhibited most productive scale size. Tobit analysis revealed that both pure technical efficiency and scale efficiency influenced negatively by number of branches per bank, whereas positively influenced by total assets. Share of priority sector advances and asset quality was having positive influence on scale efficiency.

Das et al (2005) estimated various efficiency scores of Indian banks during 1997-2003 using DEA. This study adopted the ‘intermediation’ approach to measure the efficiency. Borrowed funds, number of employees, fixed assets and equity were used as inputs. And the outputs included investments, performing loan assets and other non-interest fee based income.

This paper found that Indian banks were not much differentiated with respect to input oriented or output oriented technical efficiency and cost efficiency while differences were found in terms of revenue efficiency and profit efficiency. The results stressed the need for choosing a proper mix in shaping the revenue and profitability of Indian banks. Bank size, ownership and being listed on the stock exchange were some of the factors that had a positive impact on average profit efficiency and to some extent revenue efficiency scores. The paper also concluded that the median efficiency scores of Indian banks in general and of bigger banks in particular had improved during the post reform period.

Extended the purview of efficiency analysis to the private as well as to foreign banks operating in India, Varadi et al (2006) employed the DEA on the data relating to 27 public sector, 30 private and 36 foreign banks during the period 1999-2000 to 2002-03. Considering four indicators namely, productivity, profitability, financial management and
asset quality, the study came out with an important finding that the public sector banks were the most efficient followed by the foreign and private banks.

Sensarma (2006) studied efficiency and productivity of schedule commercial banks in India during the period 1986-2000 using stochastic frontier analysis. This paper obtained cost inefficiency and its determinants. Then using the parameters and efficiency estimates from the frontiers, various measures of productivity and their components were computed. The approach used in this was valued added approach. Outputs used in this study were value of fixed deposits, saving deposits, current deposits, investments and loans and advances. Labor and capital were the two inputs.

The results indicated that although there were cost line efficiencies in the Indian banking sector, they had been declining over time even while deregulation led to a slowdown in the rate of decline. The paper found that total factor productivity had gone up for all bank groups during the period under study. This suggested that deregulation achieved the aim of reduction in intermediation costs and improving productivity. The study concluded that public sector banks had performed well like the private banks in the post deregulated period both in terms of cost efficiency as well as TFP. Foreign banks had been poor performers in terms of cost efficiency and productivity. Performance of new private banks in terms of cost efficiency and TFP appears to have been best in the industry.

Productive performance trends of Indian commercial banks in terms of cost and technical efficiency for the period 1997-98 to 2004-05 using DEA was examined by Sahoo (2006). The study followed the intermediation approach. The inputs used were borrowed funds, labor and fixed assets and the outputs were investments, performing loan assets and non interest income.
The results showed that the average annual trends in technical efficiency for all ownership groups had improved. The foreign banks had a leading edge over the nationalized banks in both operational and price measures of performance. The study found that there was higher cost efficiency per private banks when compared the nationalized banks.

Using the stochastic frontier analysis, Mahesh and Bhide (2008) examined the efficiency levels of Indian banks for the period 1985-200. The study estimated the bank specific cost, profit and advance efficiencies.

The results showed that while loan advance efficiency had not shown much improvement after deregulation, cost and profit efficiencies showed varying trends for different bank groups. Public sector banks ranked first, in two of the three efficiency measures. The results also showed that competition had a significant impact on the efficiency levels of commercial banks across all three efficiency measures.

The impact of financial regulations on cost and profit efficiency of Indian commercial banks during the post reform period 1992-04 was examined by Das and Ghosh (2009). The sample covered all commercial banks in India. The study used the non-parametric data envelopment analysis to estimate cost and profit efficiency. The study also analyses the factors behind the possible differences in efficiency. The study adopted the intermediation approach. The inputs chosen were: deposits, number of employees, fixed assets and equity. The outputs were investments, loans and advances and other non-interest fees based incomes.

The findings indicated high levels of efficiency in costs and lower levels in profits, testifying the importance of inefficiencies on the revenue side of banking activity. Profit efficiency of banks which are listed in the stock market is notably higher as compared to
their unlisted counterparts. Also profit efficiency was found to differ significantly across bank ownership. The study also found that bank size, deposit mix, and prudential parameters such as capital position and delinquent loans were important factors that drive the differences in efficiency.

Sahoo and Tone (2009) examined the role of competition on profit change and its drivers using radial and non-radial DEA models. The study had pointed out that the increasing efficiency change trends in all ownership groups after 2002 indicated that the Government reform process instituted on the banking industry had a favorable effect on the performance of the Indian banking sector. Further it was noted that despite the fact that nationalized banks were the oldest banks, their output and resource allocation behaviors did not reflect their learning experience.

Kumar and Gulate (2010) analyzed the trends of cost efficiency and its components across PSBs during the post deregulation period 1992-93 to 2007-08 using DEA. The study examined the issue of convergence in cost, technical and allocative efficiency levels of Indian PSBs. Empirical results indicated that deregulation had a positive impact on cost efficiency levels of PSBs. Further, technical efficiency of PSBs followed an upward trend while allocative efficiency followed a path of deceleration. The convergence analysis revealed that the inefficient PSBs were not only catching up but also moving ahead than the efficient ones.

Ray and Das (2010) measured cost and profit efficiency of all major Indian commercial banks using Data Envelopment Analysis, analyzed the possible determinants of measured efficiency, and examined the statistical distribution of the efficiency using the nonparametric methods during the post-reform period of seven years beginning with the financial year 1996–97. Inputs and outputs of banks were selected based on the asset
approach which can be viewed as a variant of the intermediation approach. Four inputs – 
(borrowed) funds (deposits and other borrowings), number of employees, fixed assets, 
and equity and three outputs- investments, performing loan assets, and other non-interest 
(fee-based) incomes were selected.

The results showed that there was considerable variation in average levels of profit 
efficiency across various ownership categories of banks. In general, state owned banks 
were found to be more efficient than their private counterparts. Further, efficiency tends 
to be low among the small banks (assets up to Rs. 50 billion), indicating that at the 
existing scale of operations, these banks were operating far below the efficient frontier. 
The study also examined the distribution of efficiency using nonparametric kernel density 
estimates and revealed that there was a rightward-shift of the efficiency distribution over 
the years. The major part of the shift came from the state owned banks. Based on the 
conditional distribution, the study found strong evidence of ownership explaining the 
efficiency differential of banks. Additionally, bank size and product-mix were also found 
to be important, although to a lesser extent.

Tabak and Tecles (2010) analyzed the efficiency of the banking sector in India during the 
period of 2000–2006. The study had employed a Bayesian stochastic frontier to measure 
banking efficiency and also tested for the inclusion of off-balance sheet data in model 
specification. Cost and profit efficiencies were estimated s deviation from the frontier. 
Four outputs: loans (net of provisions), other earning assets, deposits and off-balance 
sheet items and three input prices price of funds (PF)

Kumar and Gulati (2010) appraised the efficiency, effectiveness, and performance of 27 
public sector banks (PSBs) operating in India by using a two-stage performance 
evaluation model using the cross-sectional data for the financial year 2006/2007. The
technique of data envelopment analysis had been used for computing the efficiency and effectiveness scores for individual PSBs. The overall performance scores have been derived by taking the product of efficiency and effectiveness scores.

The empirical results revealed that high efficiency did not stand for high effectiveness in the Indian PSB industry. A positive and strong correlation between effectiveness and performance measures was noted. Further, on the efficiency front, State Bank of Travancore appeared as an ideal benchmark, while State Bank of Bikaner and Jaipur, and State Bank of Mysore emerge as ideal benchmarks on the effectiveness front.

Rakhe (2010) analyzed the financial performance of foreign banks in comparison with other bank groups in India. The study had also examined the determinants of profitability in the Indian banking sector using panel data regression analysis using a sample of 59 banks, which include 14 FBs, 14 old PrSBs, 5 new PrSBs and 26 PSBs. The study found that access to low cost funds, diversification of income, adequate other income to fully finance the operating expenses are the important factors leading to the higher profitability of foreign banks vis-à-vis other bank groups in India. The study also indicated that efficiency of fund management is the most important factor determining profitability in the banking system followed by generation of other income.

Zhao et al (2010) examined the impact of financial sector reforms on the cost structure characteristics and on the ownership–cost efficiency relationship in Indian banking also examined the impact of reforms on the dynamics of competition in the lending market. They had estimated a cost frontier and a partial adjustment model. They used a two-input, three-output specification for the cost frontier model. The book value of performing loans (measured as the difference between total loans and non-performing loans), other earning
assets, and fee-based income as output and two inputs total loanable funds and non-interest operating costs were selected.

Results of the study indicated that commercial banks changed both their input mix and output composition to accommodate the changes in the regulatory environment. Pure cost technology worsened at the initial stages of the reform, but improved after 1996. There was only an upward shift of the cost frontier after 1997, and did not find significant structural break in the efficient cost function associated with the change of policy focus. Indian commercial banks accomplished the majority of the adjustments to their production process before the change in policy measures. The study further opined that the reforms had affected the ownership–cost efficiency relationship. The analysis of the dynamics of competition in the lending market also suggested a stronger competitive market forces in 1998–2004, despite tighter prudential norms.

In an interesting paper, Rajan et al (2011) addressed the issue of endogeneity of multiple outputs in a model of multiple-output and multiple-input production function frontier using semi-parametric estimation methods, in the context of examining technical efficiency and productivity performance of Indian scheduled commercial banks during the period 1979-2009. More specifically, the study introduced multivariate kernel estimators for the joint distribution of the multiple outputs and correlated random effects, to overcome the endogeneity issue. Following the intermediation approach and considering total loans and total investments as measures of output, the study concluded there were productivity and efficiency gains due to economic reforms.

3.4 Concluding Remarks:
From the foregoing review, it is clear that there are quite a few interesting issues associated with measuring efficiency of banks. These include:

i) Identifying the inputs and outputs for implementing the DEA and SFA

ii) Choosing the type of efficiency such as technical, allocative, profit, cost, advances, and productive efficiencies.

iii) Decomposition of cost efficiency into allocative and technical efficiencies

iv) Choice between the intermediate and operating approaches in the case of DEA

v) Identification of determinants of efficiency measures which would explain the efficiency differences. This may be done using tobit analysis and regressions analysis.

vi) Functional form of the frontier – flexible or translog or multi – product cost function.

For the DEA, the input variables that have been identified include labour / number of employees, fixed assets, total deposits, other non-interest expenses, interest expenses, loans and contingent liabilities. Similarly, the output variables include total loans and advances, short-term securities, interest and related revenues, non-interest revenues, total liquid assets and investments, over draft and inter-bank placements etc.

The factors that have been identified to determine efficiency include bank size, profitability, capital adequacy ratio, number of branches, ownership, deposit-mix. Similar to DEA, the SFA is based on a parametric frontier (flexible, translog or a multi-product cost function) the estimation of which facilitates computation of efficiency measures.
This method also requires an explicit identification of input and output variables. This analysis may be supplemented with tobit analysis to arrive at factors that would influence differences in efficiency measures across banks.

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