ABSTRACT

This study develops a multidimensional framework using data envelopment analysis as a benchmarking tool to assess the performance of the commercial banks in India. Using data envelopment analysis approach, this study compares the relative performance of 35 banks against one another with eight variables as the benchmark parameters. This study finds that most of the banks are consistently performing well over a period from 2005 to 2009. The study also shows the areas in which inefficient banks are lagging behind and how they can improve their performance to bring them at par with the efficient commercial banks.

INTRODUCTION

Data Envelopment Analysis (DEA) is a very popular technique that aids managers in making decisions in a multidimensional framework. Although, there are many methods and techniques to design decision processes that rank-order alternatives, but DEA also illustrates how an alternative can be improved. Thus DEA is an excellent tool for practitioners who can use this mathematical modeling technique to benchmark different decision-making units. This study illustrates the use of Data Envelopment Analysis to study the efficiency of commercial banks in India. For the past three years, the developed world has been experiencing many financial problems such as subprime lending, toxic assets, stricken banks, and over leverage. Usually the global financial turbulence hits the emerging markets harder than the developed market counterparts. However, the recent financial crisis has seen a reversal of roles between the developed markets and emerging markets. The emerging markets rebounded much more quickly, while the United States of America, the world’s biggest economy, along with other developed markets continue to struggle. Therefore, evaluating the performance of the commercial banks in an emerging market like India is an important issue that can offer further insight into the progress made by these nations using Data Envelopment Analysis.

Data Envelopment Analysis is a technique that assesses the productive efficiency of homogenous operating units such as schools, hospitals, banks or utility companies. DEA approach is a powerful technique for performance measurement, because of its objectivity, ability to handle multiple inputs and multiple outputs that can be measured in different units. Also, in contrast to non-parametric techniques such as Stochastic Frontier, DEA approach does not require specification of any functional relationship between inputs and outputs or a priori specification of weights of inputs and outputs. DEA provides gross efficiency scores based on the effect of controllable and uncontrollable factors. We examine the performance of Indian commercial banks during the period 2005 to 2009. This time period covers before crisis and during crisis time. In particular, the behavior of profitability, cost of intermediation, efficiency, soundness of the banking system, and industry concentration are examined in this paper.
The rest of the paper is organized along the following lines. Section II provides a review of literature that relates to the data envelopment analysis approach. Section III discusses the data envelopment analysis model. Section IV discusses the data and methodology being used in this paper and section V provides an empirical analysis of our results. The paper provides a summary and conclusion of our results in section VI.

LITERATURE REVIEW

Several studies have explored the use of data envelopment analysis models to evaluate the relative efficiency of banks. Kumar and Gulati (2010) evaluate the efficiency, effectiveness, and performance of Indian public sector banks using DEA models. They report that there is not much relationship between efficiency and effectiveness in Indian public sector banks, while performance and efficiency are positively related. Ray and Das (2010) find considerable variation in average levels of profit efficiency across various ownership categories of Indian banks. In general, state owned banks are found to be more efficient than their private counter parts. Staub, Souza, and Tabak (2010) investigate cost, technical and allocative efficiencies for Brazilian banks in the recent period (2000-2007). State-owned banks are significantly more cost efficient than foreign, private domestic and private with foreign participation. Tsolas (2010) provides a framework for evaluating the overall performance of bank branches in terms of profitability efficiency and effectiveness. The study highlights the importance of encouraging increased profitability and efficiency throughout the branch network of the commercial banks. Zhao, Casu, and Ferrari (2008) examine the impact of regulatory reform on the performance of Indian commercial banks. Foreign banks appear to have acted as technological innovators when competition increased, which added to the competitive pressure in the banking market.

Shanmugam and Das (2004) measure technical efficiency of Indian banks in four different ownership structures during the reform period of 1992-1999. They find that the efficiencies of raising interest margin are time invariant, while the efficiencies of raising other outputs -non-interest income, investments and credits - are time varying. Das and Ghosh (2006) report that during the period 1992-2002, medium-sized public sector banks performed reasonably well and are more likely to operate at higher levels of technical efficiency. They report a close relationship between efficiency and soundness as determined by bank's capital adequacy ratio. Their study also shows technically more efficient banks have, on an average, less non-performing loans. Mostafa (2007) uses DEA to evaluate the relative efficiency of top 50 Gulf Cooperation Council (GCC) banks. The study reports significant room for improvement for the top 50 GCC banks.

Rezvanian, Rao, and Mehdian (2008) used a nonparametric frontier approach to examine the effects of the ownership on the efficiency, efficiency change, technological progress and productivity growth of the Indian banking industry over the period 1998 to 2003. They reported that foreign banks were significantly more efficient when compared to other banks, i.e. the Indian privately-owned and publicly-owned-banks. The findings also provided evidence to indicate that a large number of banks operated below their optimal scale. Kao and Liu (2004) compute efficiency scores based on the data contained in the financial statements of Taiwanese banks. They use this data to make advanced predictions of the performances of 24 commercial banks in Taiwan. Pille and Paradi (2002) analyze the financial performance of Ontario credit unions. They develop models to detect weaknesses in Credit Unions in Ontario, Canada. Halkos and Salamouris (2004) explore the efficiency of Greek banks with the use of a
number of suggested financial efficiency ratios for the time period 1997–1999. They show that DEA can be used as either an alternative or complement to ratio analysis for the evaluation of an organization’s performance. The study finds that the higher the size of total assets the higher the efficiency. Neal (2004) investigates X-efficiency and productivity change in Australian banking between 1995 and 1999 using DEA and Malmquist productivity indexes. It differs from earlier studies by examining efficiency by bank type and finds that regional banks are less efficient than other bank types. The study concludes that diseconomies of scale set in very early, and hence are not a sufficient basis on which to allow mergers between large banks to proceed. Paradi and Schaffnit (2004) evaluate the performance of the commercial branches of a large Canadian bank using DEA. Chen et al. (2005) study the efficiency and productivity growth of commercial banks in Taiwan before and after financial holding corporations’ establishment. They employ a DEA approach to generate efficiency indices as well as Malmquist productivity growth indices for each bank. Howland and Rowse (2006) assess the efficiency of branches of a major Canadian bank by benchmarking them against the DEA model of US bank branch efficiency. Sufian (2007) uses DEA approach to evaluate trends in the efficiency of the Singapore banking sector. The paper uses DEA approach to distinguish between technical, pure technical and scale efficiencies. Sanjeev (2007) evaluates the efficiency of the public sector banks operating in India for a period of five years (1997–2001) using DEA. The study also investigates if there is any relationship between the efficiency and size of the banks. The results of the study suggest that no conclusive relationship can be established between the efficiency and size.

MODEL

The Data Envelopment Analysis Model

Data Envelopment Analysis (DEA) (Charnes et al., 1978) model uses linear programming to measure the comparative performance of different organizational units. Further, this generalized optimization technique measures the relative performance of different decision-making entities that have multiple objectives (outputs) and multiple inputs structure. In the DEA terminology, entities/organization units under study are called Decision-Making Units (DMUs). In our study, the DMUs are the seven retailers under analysis. DEA measures the efficiency with which a DMU uses the resources available (inputs) to generate a given set of outputs. The DEA methodology assesses the performance of the DMU using the concept of efficiency or productivity, defined as a ratio of total outputs to total inputs. Further, the DEA model estimates relative efficiency, which is with reference to the best performing DMU or DMUs (in case multiple DMUs are most efficient). The DEA allocates an efficiency score of unity or 100 percent to the most efficient unit. The low-performing DMUs’ efficiency can vary between 0 and 100 percent in comparison to the best performance.

DATA AND METHODOLOGY

The data for this study was obtained from CNBC’s moneycontrol.com website. The sample consists of 20 state owned banks and 15 private banks. Data covers the fiscal year ending March 31st 2005 to March 31st 2009. We used eight financial variables to evaluate the efficiency of the banks in pre- and post-economic crisis period ranging from 2005 to 2009. Given the significance of banking in economic growth, banks are considered private companies with a public purpose. They seek to create value for all.

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the stakeholders and maximize shareholder wealth subject to the various risks and within the constraint of market competition, social constraints, and the legal/regulatory framework. The private nature of banks requires them to make profits to be viable and the public nature of banks emphasizes safety and soundness of the bank’s operations. Profitability is important for the survival of a bank, but safety and security is also critical for the survival of the financial system. Every bank makes trade-offs between the profitability level it is striving to achieve and the risks it is willing to take. When evaluating a bank, an analyst should consider both its profitability and its financial condition. Taken alone, short-term profit trends can be misleading. For example, if a bank achieves loan growth by engaging in excessively risky lending, it may be vulnerable to developments that would hurt its earnings or even threaten its survival over time. Therefore, in order to evaluate banks, we consider the following four broad sets of ratios that capture the private-public nature of banking: Profitability Ratios, Cost of Intermediation, Management Efficiency Ratios, and Safety Ratios. The profitability ratios are used to measure how well a bank is performing in terms of profit. The profitability ratios can also be defined as the financial measurement that evaluates the capacity of a business to produce yield against the expenses and costs of business over a particular time period. Profitability of a bank is assessed through:

- **Return on Assets**: Return on assets is a comprehensive measure of bank profitability and is computed by dividing bank’s net income by its total assets.
- **Interest income relative to total funds**: Interest income relative to total funds also known as yield on earning assets is calculated by dividing interest income on earning assets by the value of these assets during the same period. For the Indian commercial banks, we use interest income relative to total funds as a measure of the yield on earning assets.
- **Intermediation costs**: Reflect the cost of transforming deposits from one set of customers into loans for another set of customers. Cost of intermediation can also be used as an indicator of competitiveness in banking industry and can be measured in several different ways:
  - **Interest Spread**: The difference between interest earned and interest expended is one measure of the cost of intermediation. Higher difference will point to a lower cost of intermediation and lower difference will point to a higher cost of intermediation.
  - **Interest Expense to Interest Earned Ratio**: Interest expense represents the cost of obtaining deposits and interest earned the revenue on the loans made. Therefore, this ratio is another way of measuring the cost of intermediation.

Management efficiency ratios for banks mainly focus on the costs other than interest. We use the following two ratios to assess management efficiency of Indian banks.

- **Asset Utilization Ratio**: The efficiency with which a bank utilizes its assets.
- **Efficiency Ratio**: This ratio is based on noninterest expenses divided by operating revenue. Noninterest expenses represent all expenses incurred in operations, including such items as personnel and occupancy costs (salaries, technology, building, supplies, and administrative expenses). Operating revenue includes net interest income (interest revenue less interest expense) plus fees income. This ratio is a measure of a bank’s productivity based on costs required to generate each dollar of revenue. This reflects the costs involved in maintaining branches and servicing retail accounts. A lower efficiency ratio translates into lower operational costs, which means greater operational efficiency.

A safe and sound banking system is critical for a healthy financial market. Evaluation of a bank must consider the risks that the bank is taking in order to remain profitable. We use two ratios to evaluate riskiness of banks:

- **Debt leverage**: Banks are usually highly leveraged organizations. Banks borrow money so that
they can expand their capacity to earn more money by either expanding their facilities or by making additional loans for which they do not have sufficient deposits. For the commercial banks in India, we use total debt divided by owners’ funds as a measure of debt leverage.

- Capital Adequacy Ratio: Bank capital plays a very important role in the safety and soundness of individual banks and the banking system. Capital adequacy norms ensure that capital should be adequate to absorb unexpected losses or risks involved. If there is higher risk, then it would be necessary to provide back up with capital. Capital Adequacy measures the strength of the bank.

**DATA ENVIRONMENTAL MODEL**

Besides the mathematical and computational requirements of the DEA model, there are many other factors that affect the specifications of the DEA model. These factors relate to the choice of the DMUs for a given DEA application, selection of inputs and outputs, choice of DMUs for a given DEA application, selection of inputs and outputs, choice of a particular DEA model (e.g. CRS, VRS, etc.) for a given application, and choice of an appropriate sensitivity analysis procedure (Ramanathan, 2003). Due to DEA’s non-parametric nature, there is no clear specification search strategy. However, the results of the analysis depend on the inputs/outputs included in the DEA model. There are two main factors that influence the selection of DMUs – homogeneity and the number of DMUs. To successfully apply the DEA methodology, we should consider homogenous units that perform similar tasks, and accomplish similar objectives. In our study, the banks are homogenous as they compete with each other in the same market. Furthermore, the number of DMUs is also an important consideration. The number of DMUs should be reasonable so as to capture high performance units, and sharply identify the relation between inputs and outputs. There are some simple rules of thumb that guide the selection of inputs and outputs, and the number of participating DMUs.

To study the performance of these banks, we consider eight factors: return on assets, interest income relative to total funds, interest spread, Interest Expense to Interest Earned Ratio, Asset Utilization Ratio, efficiency ratio, debt leverage, and capital adequacy. Out of these eight factors, we specified efficiency ratio, interest expense to interest earned ratio, and loan to total funds ratio as input, because if a bank has lower efficiency ratio and low debt, it is an indicator of superior performance. All other factors will be considered as output factors as a higher value of these variables improves the efficiency or performance of the bank. Finally, the choice of the DEA model is also an important consideration. We should select the appropriate DEA model with options such as input maximizing or output minimizing, multiplier or

2 The following are the guidelines for DMU model selection:

a. The number of DMUs is expected to be larger than the product of number of inputs and outputs (Darrat et. Al., 2002; Avkiran, 2001) to discriminate effectively between efficient and inefficient DMUs. The sample size should be at least 2 or 3 times larger than the sum of the number of inputs and outputs (Ramanathan, 2003).

b. The criteria for selection of inputs and outputs are also quite subjective. A DEA study should start with an exhaustive, mutual list of inputs and outputs that are considered relevant for the study. Screening inputs and outputs can be quite quantitative (e.g. statistical) or qualitative that are simply judgmental, use expert advice, or use methods such as analytical hierarchy process (Saaty, 1980). Typically inputs are the resources utilized by the DMUs or condition affecting the performance of DMUs. On the other hand, outputs are the benefits generated as a result of the operation of the DMUs, and records higher performance in terms of efficiency. Typically, we should restrict the total number of inputs and outputs to a reasonable level. As the number of inputs and outputs increases, more number of DMUs get an efficiency rate of 1, as they become too specialized to be evaluated with respect to other units (Ramanathan, 2003).
envelopment, and constant or variable returns to scale. DEA applications that involve inflexible inputs or not fully under control inputs should use output-based formulations. On the contrary, an application with outputs that are an outcome of managerial goals, input-based DEA formulations are more appropriate. In addition, for an application that emphasizes inputs and outputs, we should use multiplier version. Similarly, for an application that considers relations among DMUs, envelopment models are more suitable. Furthermore, the characteristics of the application dictate the use of constant or variable returns to scale. If the performance of DMUs depends heavily on the scale of operation, constant returns to scale (CRS) is more applicable, otherwise variable returns to scale is a more appropriate assumption.

In our study, the relationship among these banks is an important consideration as they are all commercial banks. Therefore, we select the envelopment models for our analysis. In addition, inflation is not a very flexible input that cannot be immediately controlled. Therefore, output-based formulation is recommended for our study. Furthermore, the performance of these banks does not depend on the scale of operations, thus variable returns to scale is safe assumption. Also, the structure of the DEA model (in envelopment form) uses an equation and separate calculation for every input and output. Therefore, all the input and output variables can be used simultaneously and measured in their own units.

**EMPIRICAL ANALYSIS**

Each of the banks is a homogenous unit, and we can apply the DEA methodology to asses a comparative performance of these banks. The study evaluates the progress of the commercial banks by tracking the gains (or losses) made by each of the 35 banks. Using the DEA methodology, we can calculate an efficiency score for the 35 banks on a scale of 1 to 100. We analyzed and computed the efficiency of the banks for the period 2005-2009. Table 2 illustrates the efficiency scores and the rankings of the 35 banks from the year 2005-2009. As illustrated in table 2, in the year 2005, 21 banks are 100% efficient as compared to all other banks. The other banks in the order of increasing efficiency in the range of 80%-89% efficiency are: ING Vysya Bank, Development Credit Banks, Dhanalakshmi Bank, Bank of India, and UCO Bank. Dena Bank, Syndicate Bank, Canara Bank, Union Bank of India, Bank of Baroda, State Bank of India, Axis bank, Vijaya Bank, and Indian Bank are in the range of 90%-99% efficiency. In the year 2006, 20 banks were 100% efficient and on the efficiency frontier. The other banks in the order of increasing efficiency in the range of 80%-89% efficiency are: ING Vysya Bank, UCO Bank, Syndicate Bank, and Dena Bank. Bank of India, Union Bank of India, State Bank of India, Canara Bank, Vijaya Bank, Central Bank of India, Bank of Maharashtra, Punjab National Bank, Jammu and Kashmir Bank, Corporation Bank, and Oriental Bank of are in the range of 90%-99% efficiency. In 2007, 9 banks are 100% efficient, and the remaining 27 banks are inefficient in the range of 74% to 96%. In the year 2008, 12 banks are 100% efficient, and the remaining 24 banks were inefficient within the range of 85%-98%. In the year 2009, 11 banks are efficient, and 25 banks are inefficient with efficiency levels in the range of 88%-99%. Figure 1 illustrates the efficiency factor on the radial axis for the year 2009. The pareto-efficient banks form the efficiency frontier, and the inefficient banks are below the efficiency frontier.

We present the score in percentage value varying between 0% and 100%. We find that efficiency of Indian Bank, Kotak Mahindra Bank, Yes Bank, Bank of Rajasthan, Federal Bank, HDFC Bank, Jammu and Kashmir Bank, Development Credit Bank, Karnataka Bank, ICICI Bank, and Karur Vysya Bank is 100%. On the other hand, UCO Bank, IDBI Bank, State Bank of Mysore, Oriental Bank of Commerce, Vijaya Bank, Central Bank of India, Canara bank, Andhra Bank, ING Vysya Bank, Allahabad Bank, Syndicate Bank, Bank of Baroda, Dhanalakshmi bank, Bank of Maharashtra, Indian Overseas Bank,
Dena Bank, Union Bank of India, Indusland Bank, Punjab National Bank, Axis Bank, Bank of India, and City Union Bank rank from 12 to 35 in the order of decreasing efficiency of 99%, to 88%. This means that the observed levels of current return on assets, interest income relative to total funds, interest spread, Asset Utilization Ratio, and capital adequacy of Allahabad Bank are .91 times the maximum output level that Allahabad Bank can secure with its return on assets, interest income relative to total funds, interest spread, Asset Utilization Ratio, and capital adequacy. The same rationale applies to all the other inefficient banks. Table 2 illustrates the efficiency scores and the corresponding ranking of the thirty five banks in the year 2009. Figure 2 illustrates the trend in the graphical form for all banks from the year 2005 to 2009. As UCO Bank, IDBI Bank, State Bank of Mysore, Oriental Bank of Commerce, Vijaya Bank, Central Bank of India, Canara bank, Andhra Bank, ING Vysya Bank, Allahabad Bank, Syndicate Bank, Bank of Baroda, Dhanalakshmi bank, Bank of Maharashtra, Indian Overseas Bank, Dena Bank, Union Bank of India, Indusland Bank, Punjab National Bank, Axis Bank, Bank of India, and City Union Bank are inefficient for the year 2009; the next step is to identify the efficient peer group or banks whose operating practices can serve as a benchmark to improve the performance of these banks. Table 3 illustrates the peer group for the inefficient banks.

As shown in the table, Bank of Rajasthan, ICICI Bank, and Kotak Mahindra serve as peer for Allahabad Bank. In addition, Allahabad Bank is more comparable to Kotak Mahindra (weight 37%) and less comparable to its more distant peer Bank of Rajasthan (32%), and far distant peer ICICI Bank (31%). Thus, Allahabad Bank should scale up its efficiency ratio, interest expense to interest earned ratio, and loan to total funds ratio to make them comparable with Kotak Mahindra. Similarly, Andhra Bank has ICICI Bank (53%) as the closest peer that it should emulate and Kotak Mahindra (43%) as the distant peer bank and Bank of Rajasthan (4%) that can also be investigated. Bank of Baroda has Kotak Mahindra (55%) as its immediate peer, and ICICI Bank (44%) as its next distant peer, and Bank of Baroda (1%) as its far distant peer. Similarly, Bank of India has Indian Bank, Federal Bank, ICICI Bank, and Karur Vysya as its peers. Similarly, we can apply the same rationale to Canara Bank, Central Bank of India, Corporation Bank, Dena Bank, IDBI Bank, Indian Overseas Bank, Oriental Bank of Commerce, Punjab National Bank, State Bank of India, State Bank of Mysore, Syndicate Bank, UCO Bank, Union Bank of India, Vijaya Bank, Axis Bank, Bank of Maharashtra, City Union Bank, Dhanalakshmi Bank, Indusland Bank, and ING Vysya Bank. ICICI Bank and Kotak Mahindra Bank are the most immediate or immediate peer for most of the inefficient banks. On the other hand, Bank of Rajasthan is the distant or far distant peer for twenty inefficient countries. Similarly, Jammu and Kashmir Bank is the far distant peer for four of the inefficient banks and an immediate peer for Indian Overseas Bank. HDFC Bank is the far distant peer for three of the inefficient banks and immediate peer for Axis Bank. Therefore, ICICI Bank and Kotak Mahindra Bank are the most efficient bank among all the banks as not only are 100% efficient, but also serves as the role model for all (except three) banks.

Similarly, Bank of Rajasthan is the next most efficient bank among the group of given banks. Jammu and Kashmir Bank serves as the next immediate peer bank for Indian Overseas Bank as the characteristics of Indian Overseas resemble Jammu and Kashmir Bank. Similarly, HDFC Bank is the immediate peer for Axis Bank as the two banks share similar characteristics. Thus, Jammu and Kashmir Bank and Axis Bank are the next most efficient banks among the group of banks under consideration. Karur Vysya Bank is the immediate peer for City Union Bank and far distant peer for Bank of India. This is quite expected as the characteristics of inefficient banks match the peer banks. The efficient peer banks have a similar mix of input-output levels to that of the corresponding inefficient bank, but at more absolute levels. The efficient banks generally have higher output levels relative to the bank in question. The features of efficient peer banks make them very useful as role models that inefficient
banks can emulate to improve their performance. Furthermore, ICICI Bank and Kotak Mahindra Bank are used as an efficient peer to almost all Pareto-inefficient banks, so their frequency of use as an efficient-peer, expressed as a percentage of the number of pareto-inefficient banks, is 88%. Bank of Rajasthan is an efficient peer to seventeen banks with a frequency rate of 71%. Indian Bank is an efficient peer to six banks with net percentage of 25%. In addition, Development Credit Bank and Karur Vysya Bank have the peer efficiency frequencies of 8% each. Thus, we have enhanced confidence that Development Credit Bank and Karur Vysya Bank are truly well performing banks as they outperform all the other banks. Similarly, Karnataka Bank, Federal Bank, and yes Bank serve as a peer to one of the inefficient banks. Furthermore, these banks are more likely to be a better role model for less efficient banks to emulate because their operating practices and environment match more closely those of the bulk of banks. Table 4 displays the benchmarking factor and the hit percentage of efficient bank.

After calculating the efficiency of a bank using DEA, and identifying the efficient peers, the next step in DEA analysis is feasible expansion of the output or contraction of the input levels of the bank within the possible set of input-output levels. The DEA efficiency measure tells us whether or next bank can improve its performance relative to the set of banks to which it is being compared. Therefore, after maximizing the output efficiency, the next stage involves calculating the optimal set of slack values with assurance that output efficiency will not increase at the expense of slack values of the input and output factors. Once efficiency has been maximized, the model does seek the maximum sum of the input and output slacks. If any of these values is positive at the optimal solution to the DEA model that implies that the corresponding output of the bank (DMU) can improve further after its output levels have been raised by the efficiency factor, without the need for additional input. If the efficiency is 100% and the slack variables are zero, then the output levels of a bank cannot be expanded jointly or individually without raising its input level. Further, its input level cannot be lowered given its output levels. Thus, the banks are pareto-efficient with technical output efficiency of 1. If the bank is 100% efficient but one slack value is positive at the optimal solution then the DEA model has identified a point on the efficiency frontier that offers the same level on one of the outputs as bank A in question, but it offers in excess of the bank A on the output corresponding to the positive slack. Thus, bank A is not Pareto-efficient, but with radial efficiency of 1 as its output cannot be expanded jointly. Finally, if the bank A is not efficient (<100%) or the efficiency factor is greater than 1, then the bank in question is not Pareto-efficient and efficiency factor is the maximum factor by which both its observed output levels can be expanded without the need to raise its output. If at the optimal solution, we have not only output efficiency > 1, but also some positive slack, then the output of bank A corresponding to the positive slack can be raised by more than the factor output efficiency, without the need for additional input. The potential additional output at bank A is not reflected in its efficiency measure because the additional output does not apply across all output dimensions.

Table 5 illustrates the slack values identified in the next stage of the DEA analysis. The slack variables for 100% efficient banks as well as less than 100% efficient banks are not zero. Therefore, all the banks used in this study are not Pareto-efficient as the DEA model has been able to identify some feasible production point which can improve on some other input or output level. For example, for Allahabad Bank, besides increasing the output level of interest spread by 5.55 units, there is further scope for increasing interest to total funds by 9.26 (units), asset utilization by .01 (units), capital adequacy by 2.94 (units), and return on assets by 0.09 (units). Allahabad Bank can follow Kotak Mahindra, Rajasthan Bank, and ICICI Bank as its role models and emulate their policies. Similarly, IDBI Bank can reduce its interest expense to interest earned by 4.96 units and increase interest spread by 3.21 units, interest to total funds by 8.84 units, asset utilization by 0.02 units, capital adequacy by 3.51 units, and return on
assets by 0.45 (units) while maintaining efficient levels equivalent to that of its peers—ICICI Bank and Bank of Rajasthan. On the same lines, we can find slack values for Indian Bank. Although Indian Bank is 100% efficient, there is still scope for improvement as Indian Bank can improve its output productivity without additional inputs. Therefore, Indian Bank can increase its output factors, interest spread by 3.47 units and interest to total funds by 8.37 units. Similarly, we can find the slack factors for all the other banks. Table 5 illustrates the slack values of the relevant factors for inefficient banks.

SUMMARY AND CONCLUSIONS

Using data envelopment analysis approach, this study compares the relative performance of thirty five Indian commercial banks against one another with eight performance variables as the benchmark parameters from 2005 to 2009. By studying the time period from 2005 to 2009, we also look at the variations in the performance of these banks over a period of time to assess their progress. This study finds that ICICI Bank, Kotak Mahindra Bank, Bank of Rajasthan, HDFC Bank, and Jammu and Kashmir Bank consistently outperform all the other banks with 100% relative efficiency. Indian Bank, Bank of Rajasthan, Development Credit Bank, Federal Bank, HDFC Bank, ICICI Bank, Karur Vysya Bank, and Kotak Mahindra Bank show consistent improvement in industry performance. The study also shows the areas in which inefficient member banks are lagging behind and how they can improve their performance to bring them at par with other participating banks.

The data envelopment analysis is a powerful technique for performance measurement. The major strength of DEA is its objectivity. DEA identifies efficiency ratings based on numeric data as opposed to subjective human judgment and opinion. In addition, DEA can handle multiple input and outputs measured in different units. Also, unlike statistical methods of performance analysis, DEA is non-parametric, and does not assume a functional form relating inputs and outputs. This study finds that there is lack of convergence in the performance of 35 banks and some banks have performed more efficiently in contrast to other banks.

However, as with any other study, this study using DEA has certain limitations (Ramanathan, 2003). The application of DEA involves solving a separate linear program for each DMU. Thus, the use of DEA can be computationally intensive. In addition, as DMU is an extreme point technique, errors in measurement can cause significant problems. DEA efficiencies are very sensitive to even small errors, thus making sensitivity analysis an important component of post-DEA procedure. Also, as DEA is a non-parametric technique, statistical hypothesis tests are difficult to apply. Therefore, further extension of this study would be to perform principal component analysis of the all the DEA model combinations. Furthermore, we can also use logistic regression to test the validity of the results.

TABLES, FIGURES, & REFERENCES

Tables, figures, references, and full paper available upon request from the authors.