Performance Evaluation of Indian Commercial Banks in the Prompt Corrective Action Framework: An Assurance Region Approach

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After the onset of banking sector reform in India, the Reserve Bank of India initiated a system of Prompt Corrective Action (PCA) with various trigger points and mandatory and discretionary responses by the supervising authority on a real time basis. The PCA framework relies on three major indicators of banking sector performance: Net Non Performing Asset (NPA), Capital-To-Risk-Weighted Assets Ratio (CRAR) and Return on Assets (ROA). The present paper seeks to combine the ratio approach adopted by the Reserve Bank of India with the Assurance Region based measure of technical efficiency to find out a composite Data Envelopment Analysis (DEA) based efficiency indicator of 28 observed commercial banks for 2002-03 to 2004-05. The results show that the observed private sector commercial banks have higher mean technical efficiency score compared to those of the public sector commercial banks. Out of the 28 observed commercial banks considered for the study, six were found to be efficient. A study of the technical efficiency scores across ownership groups reveal that the observed private sector banks have higher mean technical efficiency scores compared to their public sector counterparts. Finally, most of the observed commercial banks exhibit decreasing returns to scale for the period under observation

Introduction

As an integral part of banking sector reform in India, the Reserve Bank of India (RBI) adopted a system of Prompt Corrective Action (PCA) with various trigger points and mandatory and discretionary responses by the supervising authority depending on the three major indicators of banking sector health: Net Nonperforming Asset (NPA), Capital-to-Risk-Weighted Assets Ratio (CRAR) and Return on Assets (ROA). The present paper seeks to integrate the ratio approach adopted by the RBI with the Assurance Region approach of measuring the technical efficiency of select Indian commercial banks to find out a composite Data Envelopment Analysis (DEA) based ranking in respect of each observed commercial banks.

Organization of the Paper

The paper provides an overview of the PCA framework, discusses the methodology, provides a brief review of literature, states the results, and finally concludes with observations.

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The Prompt Corrective Action Framework

Global Developments

The Prompt Corrective Action Framework (PCA) originated in the USA following the passage of Federal Deposit Insurance Corporation Improvement Act (FDICIA) in 1991. The FDICIA, 1991, stipulates that each federal banking agency will take PCA for resolving the problems of insured financial intermediary in a way which results in the least possible long-term loss to the deposit insurance fund. PCA is essentially meant for insured financial institutions which are not adequately capitalized. As per the PCA framework, banks are placed in one of the following five tiers: (1) Well Capitalized (2) Adequately Capitalized (3) Undercapitalized (4) Significantly Undercapitalized and (5) Critically Undercapitalized on the basis of three capital ratios (CRAR, Tier I to Risk Weighted Assets and Tier I to Total Assets). Every tier, (excepting the well capitalized tier), has a set of mandatory and discretionary provisions the severity of which is inversely related to the degree of capitalization. The prescribed actions under PCA include establishment of a capital restructuring plan, restrictions on deposit mobilization, cap on interest payable on deposits, new activities, acquisitions, salary of officers, asset growth, payment of dividends/management fees, etc. Banks, which are found to be undercapitalized for a prescribed period, face closure.

Apart from the US, a system of PCA regime is in existence in many other countries. Rules based on compulsory quantitative triggers (in relation to capital levels) for action by supervisors modeled on the rules set in the FDICIA, 1991 have been devised in some industrial economies and in a number of emerging market economies (e.g., Korea, Argentina, Chile, Colombia, the Czech Republic, and Hong Kong). Some of the countries (Singapore, Brazil, Mexico, Peru, Hungary, and Poland, etc.), have established a rule-based system for initiating action against banks which are unable to meet the obligations, doing business not in the interests of depositors or creditors, and which are suffering from illiquidity, insolvency, large losses, etc.

Banking Sector Supervision and PCA in India

Following the recommendations of the Committee on Financial System (1991), the regulatory and supervisory functions of the RBI were bifurcated in 1994 and the Board for Financial Supervision (BFS) was set up. The supervisory functions in respect of the commercial banking sector were entrusted to a newly created Department of Supervision which functions under the BFS. In the liberalized environment of banking; the BFS introduced a new system of banking supervision:

(a) The existing system of on-site supervision has been supplemented by a system of off-site supervision. For this, an Off-Site Monitoring and Surveillance System(OSMOS) was set up in 1995 for providing a means to ensure closer and continuous monitoring of bank performance. The off-site monitoring system is based on a prudential reporting system (on a quarterly or half yearly basis covering the following: (i) Asset Quality; (ii) Capital Adequacy; (iii) Large Exposures; (iv) Connected Lendings; (v) Ownership Patterns; (vi) Liquidity Risk; and (vii) Currency Risk.

(b) The existing system of bank inspection has been restructured for sharper focus.

(c) External auditors are being employed as a supervisory resource.

(d) Initiatives have been taken to strengthen the system of corporate governance in the commercial banks. Further, internal control and audit functions are being used as support systems for supervision.

Prompt Corrective Action

The existence of a sophisticated bank monitoring system carries no meaning unless the bank supervisor is able to intervene in the event of aberrations on a real time basis. This has resulted in the initiation of PCA mechanisms in developed financial markets which accommodate structured intervention systems in the event of declining financial health of the banks.

In the Indian context also, the RBI has envisaged a system of PCA with various trigger points and mandatory and discretionary responses by the supervising authority. The Indian PCA regime includes three major indicators of banking sector health: Net NPA, CRAR and ROA. Trigger points have been proposed as under in respect of each of the three parameters:

(1) Net NPA – (i) $>$ 10% but $<$ 15%, (ii) $\geq$ 15%,

(2) CRAR – (i) $\geq$ 6% but $<$ 9%, (ii) $\geq$ 3% but $<$ 6%, (iii) $<$ 3%,

(3) ROA – $<$ 0.25%.

The PCAs are designed to pre-empt any deterioration in the soundness of banks. Any such action, however, may not achieve the desired effect unless it is able to recognize the idiosyncratic factors. Thus, a set of mandatory and discretionary action points, in conformity with the magnitude of problems has been decided to bring about improvement in the functioning of banks. The rationale for classifying the rule-based action points into mandatory and discretionary, stems from the fact that some of the actions are essential to restore the financial health of banks while other actions will be taken at the discretion of the central bank/regulatory agency on the basis of bank-specific profile. If banks do not show improvement, in spite of the discretionary actions, some of the discretionary actions will be converted into mandatory actions.

The Conceptual Framework

Concept of Productive/Technical Efficiency

Productive efficiency of a life insurance company can be measured by comparing its performance with the best practice life insurance company in the industry following the same technology. Operating efficiency is typically measured in terms of technical efficiency. There are, however, two major alternative approaches towards defining technical efficiency: The Pareto-Koopmans approach and the Debreu-Farrell approach.

Koopmans (1951) gave a formal definition of technical efficiency: A producer is technically efficient if an increase in any output requires a reduction in at least one other output or a increase in at least one input, and if a reduction in any input requires

an increase in at least one other input or a reduction in at least one output. Because of its Paretian implication, this approach is known as the Pareto-Koopmans approach.

Another popular measure of technical efficiency is by Debreu (1951) and Farrell (1957). In case of output/revenue maximization, their measure is defined as one minus the maximum equiproportionate expansion in all outputs with given input. In case of cost minimization, the Debreu-Farrell measure is one minus the maximum equiproportionate reduction in all inputs which still allows continued production of given output. A resultant score < 1 implies that the firm is technically inefficient.

The DEA Approach

DEA is a non-parametric mathematical programming technique used for assessing evaluating and comparing the relative performances of economic units with minimal prior assumption on input-output relation. The DEA method is a generalization of Farrell's single input—single output technical efficiency measure to the multiple output—multiple input case. The methodology was originally developed by Charnes *et al.* (1978) and was later further extended by Banker *et al.* (1984).

The DEA approach constructs the efficiency frontier out of piecewise linear stretches thereby forming a convex production possibility set. In DEA frontier, efficient observations are those for which no other decision making unit or linear combination of units has as much or more of every output (given inputs) or as little or less of every input (given outputs). It envelops data sets and therefore makes no room for noise.

Estimation of Technical Efficiency Using Radial DEA Model

Let us consider a productive unit producing a scalar output Y from bundles of m inputs $x = (x_1, x_2, x_m)$.

Let (x^j, y^j) be the observed input-out bundle of firm j ($j = 1, 2, \ldots, n$). The technology is defined by the production possibility set.

$P_s = \{(x, y)$: y can be produced from $x\}$

An input-output combination (x^0, y^0) is feasible if and only if $(x^0, y^0) \in Ps$

Assuming that the firms under observation are output maximizers, the problem for any particular firm is:

Max ϕ

S.t. $\phi\, y^0 \leq \lambda\, Y$, $X^0 \geq \lambda\, X$, $\Sigma\, \lambda\, j = 1, \lambda\, j \geq 0$

Technical Efficiency $= 1/\phi$.

Input/Output Slacks in the Radial DEA Models

The linear program mentioned above gives us a radial measure of technical efficiency. However, a major weakness of the radial approach is that it cannot reflect all the identifiable potential for expansion of output and contraction of input. A firm is not efficient in the economic (Paretian) sense if output can be increased (without increasing input usage) or input usage can be reduced (without affecting output). When positive

output and input slacks are present at the optimal solution of a Charnes *et al.* (1978) or Banker *et al.* (1984) linear programming problem, the corresponding radial projection of an observed input-output combination is unable to meet the criterion of Pareto optimality and will not qualify as an efficient point.

The Assurance Region Model

The assurance region approach was developed by Thompson *et al.* (1986) for choosing a best site for the location of a high-energy physical laboratory. The approach was further developed by Thompson *et al.* (1990). The assurance region approach is discussed very briefly here:

In the radial DEA models one forms virtual input and output by (yet unknown) weights n_j (for inputs) and m_i (for outputs): virtual input $= \Sigma\, n_j$ and virtual output $= \Sigma\, m_i$.

Then one tries to determine the weight by using linear programming in a way which would maximize the ratio = virtual output/virtual input. The optimal weights will generally vary from one firm to another. Thus the weights in DEA are derived from the data instead of being fixed in advance. In the radial model, the problem can however, emerge from two specific sources:

(i) In the optimal weights (n_j^*, m_i^*) of DEA models for inefficient firms we may see many zeros. This can lead to problems in efficiency characterization.

(ii) Large differences in weights from item to item can also be a concern.

The Assurance Region approach avoids these problems by imposing restrictions on the shadow prices of inputs and/or outputs. This leads to a reconstruction of the isoquant in a manner such that no slacks can exist at the radial projection of any input/output bundle onto the modified isoquant.

For a two output (y_1, y_2)-two input (x_1, x_2) case, the linear program to be solved (for the variable returns to scale model) is:

$$\text{Max } m_1 y_1 + m_2 y_2$$

$$\text{Subject to: } m_1 y_1 + m_2 y_2 - (n_1 x_1 + n_2 x_2) \leq 0$$

$$n_1 x_1 + n_2 x_2 = 1$$

$$\Sigma m_i = 1,\ \Sigma n_i = 1,\ m_1, m_2, n_1, n_2 \geq 0$$

$$d_1 \leq m_2/m_1 \leq d_2,\ c_1 \leq n_2/n_1 \leq c_2$$

Here d_1 and d_2 are the lower and upper bounds imposed on the ratio m_2/m_1. On the other hand, c_1 and c_2 refer to the lower and upper bounds imposed on the ratio n_2/n_1.

Studies on Bank Efficiency—A Review of Literature

Quite a number of studies have been undertaken on the efficiency characteristics of Indian commercial banks in the post-reform period:

Bhattacharyya *et al.* (1997) measured technical efficiency of 70 commercial banks operating in India for the period 1986-91 using DEA. They used a two stage approach: in the first stage they calculated the radial technical efficiency scores using the DEA. In the second stage they used stochastic frontier analysis to attribute variation in the efficiency scores to three sources: temporal, ownership and noise component. The study took advances, investment and deposits as outputs while interest expense and operating expense were taken as the inputs. It was found that the public sector banks had much higher efficiency as compared to the private and foreign banks

Saha and Ravisankar (2000) examined the efficiency of the Indian public sector banks in two phases during the period 1992-95. In the first phase, they considered certain key ratios (like deposit to establishment expenses and advances to establishment expenses; and deposits to staff and advances to staff) to identify the better performing banks. In the second phase they estimated the efficiency of the in sample commercial banks using the DEA method. Four input variables were considered (interest expenditure, establishment expenditure, non-establishment expenditure) and six output variables (deposits, advances, investments, non-interest income, interest spread and total income) for their exercise. The results obtained show that the performance of the public sector banks (with the exception of a few) had improved over the years of study.

Ram Mohan and Ray (2004) compared performances of 58 public, private sector and foreign banks using a revenue maximization efficiency approach for the period 1992-2000. Loans, investments and other incomes were taken as bank outputs. Deposits and operating costs were taken as inputs. They argued that during the period, Indian banks did not have much freedom in trimming the costs especially the cost of labor. Under these circumstances, revenue maximization best describes the objective that the banks have been focusing during the period.

The results obtained relating to revenue maximization efficiency, technical efficiency and allocative efficiency reveal the following:

a) Public sector banks are significantly better placed than private sector banks on revenue maximization efficiency but there is no such difference between public and foreign banks.

b) Public sector banks are significantly better than private banks in respect of technical efficiency but not in respect of allocative efficiency.

Kumbhakar and Sarkar (2005) used the stochastic cost frontier analysis to examine the efficiency of the Indian banking system using panel data for the period 1986-2000. They used a translog specification of the cost frontier to estimate the efficiency of the individual banks. The data set related to 27 public sector banks and 23 private sector banks. The results indicated that Indian banks, on an average, do exhibit the presence of cost inefficiency in their operations. However, there is a tendency for inefficiencies to decline over time. Further, they found that deregulation in the Indian banking sector resulted in an increase in the cost inefficiency of the Indian banks and a decline in the rate of inefficiency reduction.

Das *et al.* (2005) examined the output oriented technical efficiency, cost efficiency, revenue maximizing efficiency and profit efficiency of Indian (public, private and foreign) banks for the period 1997-2003. Four inputs were considered for their study—borrowed funds (deposits and other borrowings), number of employees, fixed assets and equity. Only those banks which had at least three branches during the entire study period were included in the study.

The results show that the Indian banks are still not much differentiated if one considers input or output oriented technical efficiency or cost efficiency. However, they differ sharply if one considers revenue and profit efficiencies for performance evaluation.

Chatterjee and Sinha (2006), estimated the cost efficiency of Indian commercial banks using the DEA taking loan as the output indicator. Number of branches of the bank and borrowed capital were taken as two inputs. The results were for 1996-97, 1998-99, 2000-01 and 2002-03 respectively. The results of the cost minimizing DEA show that the mean cost efficiency of the in sample commercial banks significantly declined in 2002-03, i.e., the banks have diverged from the best practice cost frontier. Further, the in sample private sector commercial banks exhibited higher mean cost efficiency than the in sample public sector commercial banks. The public sector commercial banks lagged behind the private sector commercial banks both in respect of technical efficiency and allocative efficiency. The result may be the outcome of lending aversion behavior by the public sector commercial banks.

Outputs and Inputs for the Present Study

The present study compares 28 Indian commercial banks for 2002-03, 2003-04 and 2004-05 in respect of three operating efficiency indicators (ROA, Tier 1 capital to risk weighted asset ratio and performing advances to net advances) using DEA. Coming to the side of inputs, the following have been considered: branch, borrowings, and net worth. The commercial banks have been assumed to try to maximize the values of the operating efficiency indicators and assumed to operate under variable returns to scale.

The Output-Input correspondence, used in this paper, therefore, is Output (ROA, CRAR, Performing Advances to Net Advances) = f (Branches, Borrowings, Net Worth).

Data Source

The study relies on two data sources**:** *Trend and Progress of Banking in India*, and *Statistical Tables Relating to Banks in India* both published by the RBI on an annual basis. The output indicators have been taken from *Trend and Progress of Banking in India* and the input data have been taken from *Statistical Tables Relating to Banks in India*.

The Technical Efficiency Scores and the Returns to Scale

Tables 1-3 provide the descriptive statistics relating to the inputs/outputs for the observed years.

Table 1: Descriptive Statistics of Inputs/Outputs (2002-03)						
Particulars	**Branch**	**Borrowings (Rs. cr)**	**Net Worth**	**ROA**	**PA/NA**	**CRAR**
Max	9,102	3,05,427	17,203	1.590000	99.80000	14.15000
Min	54	8,457	457	0.000100	91.89000	5.20000
Average	1,622.107	4,33,05.50	2,620	0.948221	97.92071	7.92500
SD	1,739.144	5,59,90.31	3,241.444	0.453629	1.547579	2.38158
Source: Calculated.						

Table 2: Descriptive Statistics of Inputs/Outputs (2003-04)						
Particulars	**Branch**	**Borrowings (Rs. cr)**	**Net Worth**	**ROA**	**PA/NA**	**CRAR**
Max	9,107	3,32,050	64,884	1.960000	100	16.520000
Min	62	9,590	467	0.060000	90.380000	5.190000
Average	1,649.250	48,573.68	5,537.357	1.272500	96.739640	8.112857
SD	1,743.288	59,991.91	12,009.530	0.415998	2.147865	2.660608
Source: Calculated.						

Table 3: Descriptive Statistics of Inputs/Outputs (2004-05)						
Particulars	**Branch**	**Borrowings (Rs. cr)**	**Net Worth**	**ROA**	**PA/NA**	**CRAR**
Max	9,161	3,86,232	7,2336	1.590000	99.800000	14.15000
Min	127	11,081	440	0.000100	91.890000	5.20000
Average	1,682.464	57,295.64	6,486.107	0.948221	97.924290	7.92500
SD	1,739.906	70,193.13	13,497.530	0.453629	1.546234	2.38158
Source: Calculated.						

Table 4 shows the bank wise technical efficiency scores for the years 2002-03 to 2004-05.

Table 5 shows the returns to scale statistics of the observed commercial banks in summary form.

Table 6 presents the year wise ranks of the observed commercial banks on the basis of their technical efficiency scores.

Table 4: Bank-Wise Technical Efficiency Scores (Output: ROA, T1 CRAR, PA/NA)			
Bank	**2002-03**	**2003-04**	**2004-05**
State Bank of India	0.975451	0.9652	0.975451
Allahabad Bank	0.989889	0.983811	0.989899

(Contd...)

Table 4: Bank Wise Technical Efficiency Scores (Output: ROA ,T1 CRAR, PA/NA)

(...contd.)

Bank	2002-03	2003-04	2004-05
Andhra Bank	1	0.998998	1
Bank of Baroda	0.987604	0.970100	0.987750
Bank of India	0.974384	0.955000	0.974647
Bank of Maharashtra	0.981220	0.983684	0.985122
Canara Bank	0.983316	0.971100	0.983388
Central Bank	0.972498	0.944300	0.972717
Corporation Bank	1	1	1
Dena Bank	0.954467	0.921821	0.962146
Indian Bank	0.988852	0.976230	0.989050
Indian Overseas Bank	0.989905	0.975445	0.989963
Oriental Bank of Commerce	0.989516	1	0.989651
Punjab and Sind Bank	1	1	1
Punjab National Bank	1	0.990200	1
Syndicate Bank	0.986711	0.979330	0.986810
UCO Bank	0.973334	0.969381	0.973395
Union Bank	0.975873	0.971300	0.976074
United Bank of India	1	1	1
Vijaya Bank	1	1	1
Federal Bank	1	0.994270	0.996737
HDFC Bank	1	0.977073	1
ICICI Bank	1	0.966398	1
Indus Ind Bank	1	1	1
INGVysya Bank	0.999130	1	1
J&K Bank	1	1	1
Karnataka Bank	1	1	1
UTI Bank	1	1	1

Source: Calculated.

Table 5: Returns to Scale Statistics of the Observed Banks

Particulars	2002-03	2003-04	2004-05
No of Banks Exhibiting Increasing Returns to Scale	0	0	0
No of Banks Exhibiting Constant Returns to Scale	4	3	4
No of Banks Exhibiting Decreasing Returns to Scale	24	25	24

Source: Calculated.

Table 6: Bank Wise Ranking of Technical Efficiency Scores			
Bank	**2002-03**	**2003-04**	**2004-05**
State Bank of India	24	25	24
Allahabad Bank	16	14	16
Andhra Bank	1	11	1
Bank of Baroda	19	22	19
Bank of India	25	26	25
Bank of Maharashtra	22	15	21
Canara Bank	21	21	22
Central Bank	27	27	27
Corporation Bank	1	1	1
Dena Bank	28	28	28
Indian Bank	18	18	18
Indian Overseas Bank	15	19	15
Oriental Bank of Commerce	17	1	17
Punjab and Sind Bank	1	1	1
Punjab National Bank	1	13	1
Syndicate Bank	20	16	20
UCO Bank	26	23	26
Union Bank	23	20	23
United Bank of India	1	1	1
Vijaya Bank	1	1	1
Federal Bank	1	12	14
HDFC Bank	1	17	1
ICICI Bank	1	24	1
Indus Ind Bank	1	1	1
ING Vysya Bank	14	1	1
Jammu and Kashmir Bank	1	1	1
Karnataka Bank	1	1	1
UTI Bank	1	1	1
Source: Calculated.			

Concluding Observations

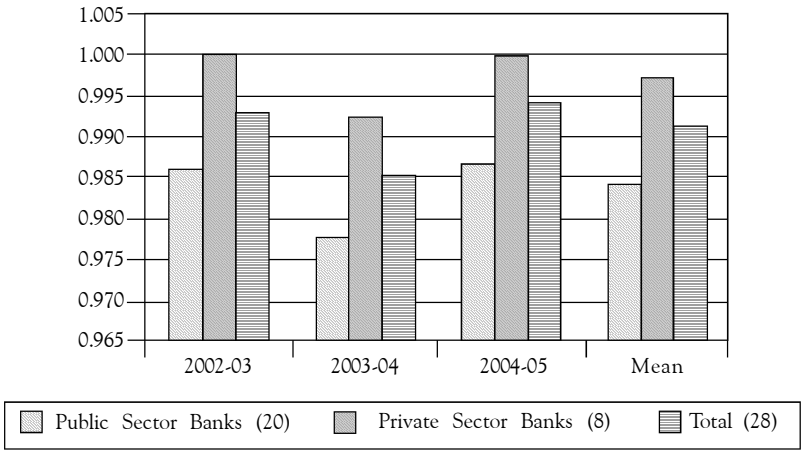
The study focuses on technical efficiency of 20 public sector and eight private sector commercial banks on the basis of key working parameters such as capital adequacy, asset quality and return on asset using the Assurance Region approach. However, out of the 28 observed commercial banks considered for the study, six commercial banks (Corporation Bank, Punjab and Sind Bank, ING Vysya Bank, Jammu and Kashmir Bank, Karnataka Bank

Table 7: Mean Technical Efficiencies of Indian Commercial Banks According to Ownership Groups

Bank Group	2002-03	2003-04	2004-05	Mean
Public Sector Banks (20)	0.986	0.978	0.987	0.984
Private Sector Banks (8)	1	0.992	1	0.997
Total (28)	0.993	0.985	0.994	0.991

Source: Calculated.

Figure 1: Mean Technical Efficiencies of Indian Commercial Banks According to Ownership Groups



and UTI Bank) were found to be efficient. Out of them, two banks (Punjab and Sind Bank and ING Vysya Bank) were declared efficient in spite of their poor showing on the front of ROA. A study of the technical efficiency scores across ownership groups reveals that the observed private sector banks have higher mean technical efficiency scores compared to their public sector counterparts (Table 7 and Figure 1). Finally, most of the observed commercial banks exhibit decreasing returns to scale for the period under observation.❖

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