Chapter - V

Empirical Analysis and Findings

5.1: Introduction

The study aims to examine the relative efficiency of Indian commercial banks during 2005-08 by utilizing Data Envelopment Analysis (DEA). Four inputs (m = 4) and four outputs (s = 4) with a sample size of 36 (n = 36) are chosen. Therefore, the sample size in this study exceeds the desirable size as per the rule of thumb (36>24) i.e. n (number of DMUs) equal to or greater than max {m × s, 3 x (m + s)} [1]. So, this study utilizes the greatest advantage of DEA methodology properly by selecting multiple inputs and multiple outputs with an accepted number of degree of freedom i.e. efficiency discriminatory powers. Majority of the previous studies considered a small number of inputs and outputs and consequently failed to capture the multidimensional nature of the Indian banking and the various aspects of performances in the present competitive market. Thus, their studies could not take advantage of the specialty of the DEA methodology i.e., the ability to handle multiple inputs and outputs situation effectively.

Table: 5.1

Summary Statistics on Input/output Data for Measuring Grand Frontier Scores

	Inputs				Outputs			
	Input -1	Input -2	Input -3	Input -4	Output-1	Output-2	Output-3	Output-4
	(No of Branches)	(No of Employees)	(Operating Expenses)	(Deposit)	(Net Interest Income)	Non-interest Income	Priority Sector Advance)	(Net Profit)
Max	9408	190420	1155785	43000466	1565230	725482	7639094	1838548
Min	105	1367	8291	289198	8942	2562	54052	11905
Average	1289	20079	135738	5689137	183174	87539	1111396	260022
SD	1651	31775	204612	7564792	268441	143213	1402197	333671

Note: Year wise summary statistics on input/ output data are presented in Annexure: 5 (A)

From summary statistics for the inputs and outputs reported in Table 5.1, it is observed that the variations among the banks in terms of selected input output data are quite big. It is noticeable that output variable (Net profit) of two banks (DLB and INV) have negative values only in the year 2005. No further action is taken since our software can deal with non-positive values.

The degree of correlation between inputs and outputs is an important issue that has great impact on the robustness of the DEA model. A correlation analysis is

imperative to establish appropriate inputs and outputs. So, in order to obtain more robust and reliable results, the sensitivity of our efficiency indices are put into test of correlation between selected input and output variables. It is found that there is a high correlation between selected input and output variables as shown in Table: 5.2.

Table: 5.2

Correlation between Input/output Variables used for Grand Frontier Scores

Input -1	1	0.971	0.865	0.914	**0.923**	**0.732**	**0.895**	**0.936**
Input -2		1	0.939	0.962	**0.975**	**0.836**	**0.941**	**0.96**
Input -3			1	0.986	**0.986**	**0.969**	**0.981**	**0.962**
Input -4				1	**0.989**	**0.938**	**0.993**	**0.984**
					1	0.918	0.977	0.977
						1	0.944	0.897
							1	0.99
								1

Note: Year wise correlations are presented in Annexure. 5 (B).

This correlation is also high in all the years under study (Annexure: 5. (B)). This is a reasonable validation of the DEA models applied in this study.

So, with this appropriate number of inputs and outputs and reasonable validation by high degree of correlation between them, the study estimates relative technical efficiency by constructing separate four annual efficient frontiers to measure year to year efficiency level of the individual banks. The study also constructs a grand frontier to estimate efficiency level over the study period (2005-08) as a whole for all the banks. Grant frontier is framed basing on the average inputs and outputs value over the study period.

As mentioned earlier, the study estimates first two types of DEA efficiencies – Overall Technical Efficiency (OTE) Pure Technical Efficiency (PTE) using input oriented CCR and BCC model respectively. Use of these two models together allows estimation of scale efficiency (SE).

Overall Technical Efficiency (OTE) or CCR efficiency under constant return to scale (CRS) assumption represents the efficiency which measures inefficiency due to wrong mix of input output configuration i.e.. operational inefficiency as well as scale

inefficiency. That is why, this efficiency is also called overall technical efficiency (OTE) or (global) technical efficiency or technical and scale efficiency.

Pure Technical Efficiency (PTE) or BCC efficiency measures efficiency without considering scale of operation. This efficiency is also rightly named as pure technical efficiency (PTE) or (local technical efficiency which provides inefficiency resulting from managerial underperformance. It is significant to note that PTE is greater than or equal to OTE since VRS frontier is piecewise boundary and closer to observed inefficient points. If a bank is BCC efficient but not CCR efficient then it is locally efficient but not globally efficient due to scale inefficiency. It is important to note that if a DMU is fully efficient under both CCR and BCC score the DMU is said to be operating in the most productive scale size i.e., scale efficiency is 100%.

Scale Efficiency (SE) - Another type of efficiency which measures whether a banking firm has the right size is known as scale efficiency (SE). This is the relationship between a firm's per unit production cost and production volume. Thus, scale efficiency (SE) based on CCR and BCC score is defined by SE = CCR score / BCC score, SE is not greater than one.

Here it is also significant to explain again that input oriented technical efficiency score obtained from CCR and BCC model indicates minimization of input use while producing at least given level of outputs i.e., how much inputs can be reduced without altering the given level of outputs produced compares with the best practice utilization of inputs.

Year wise DEA scores help to observe the trend of efficiency movement over the years under evaluation. DEA scores should not be used as a basis for comparison across the years since it measures relative efficiency not absolute efficiency. Thus, the study has analyzed the efficiency of the banks based on the grand frontier scores unless otherwise mentioned. Out of CCR and BCC efficiency, the study considers CCR efficiency scores for analysis purpose since CCR efficiency measures both technical and scale aspect of efficiency. BCC efficiency scores are mainly used to identify the source of inefficiency of the banks. Financial year 2004-05 starting from 1st April, 2004 and ending on 31st March, 2005 is written as 2005, 2005-06 as 2006 and so on.

Yearly frontier and grand frontier based various efficiency scores (OTE, PTE and SE) of the individual banks are presented in Annexure: 5. (C).

5.2: Insights of DEA Efficiency

DEA not only measures efficiency level but also indicates and helps to explain the various insights into efficiency. That is why in the first section of the analysis; this study aims to look at six issues (various insights of DEA efficiency) explained one by one –

⇒ Examination of relative efficiency of the banks in a generalized way.

⇒ Efficient and Inefficient Banks

⇒ Decomposition of Technical Efficiency

⇒ Returns-to-Scale

⇒ Reference Sets

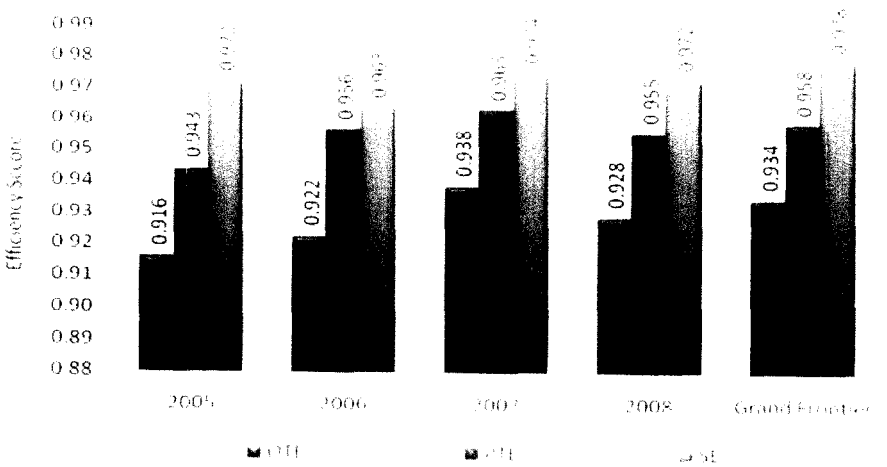
⇒ Improvement in Efficiency

5.2.1: Examination of Relative Efficiency

Average efficiency of different DEA measures are displayed in Figure: 5.1.

Figure: 5.1

Mean Scores of Different Efficiency



The average overall technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SE) based on grand frontier scores are 93.4 percent, 95.8 percent, and 97.8 percent respectively. The above results suggest that average inefficiencies of these three efficiency measures (average dispersions of banks from the best-practice banks) are 6.6%, 4.6% and 2.2% respectively. Now, we are discussing these three types of efficiencies one by one.

The summary statistics of three types DEA efficiencies are given in Table: 5.3.

Table: 5.3

Descriptive Statistics of OTE, PTE and SE scores

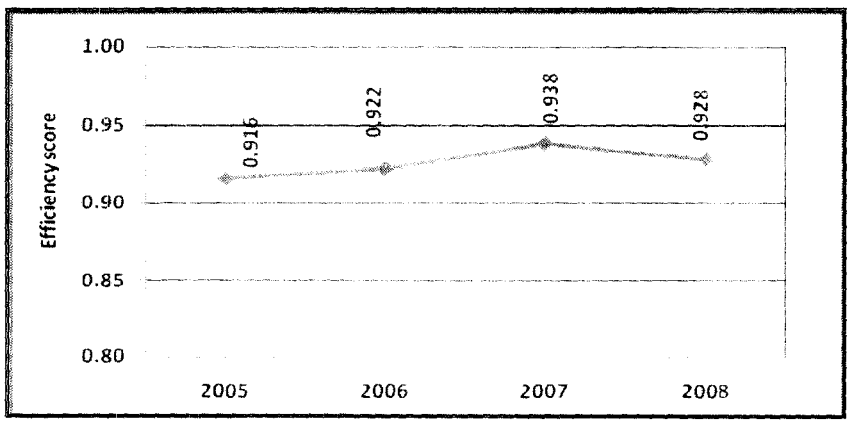
	Year Wise Frontier				Grand Frontier
	2005	2006	2007	2008	
Overall Technical Efficiency (OTE)					
No. of Banks	36	36	36	36	36
Average Efficiency (AVE)	0.916	0.922	0.938	0.928	0.934
Average Inefficiency (1 - AVE)	0.084	0.078	0.062	0.072	0.066
SD	0.104	0.100	0.080	0.084	0.086
Minimum	0.632	0.562	0.733	0.651	0.646
Maximum	1	1	1	1	1
No. of Efficient Banks (%)	15(42%)	15(42%)	17(47%)	14(39%)	16(44%)
Pure Technical Efficiency (PTE)					
No. of Banks	36	36	36	36	36
Average Efficiency (AVE)	0.943	0.956	0.963	0.955	0.958
Average Inefficiency (1 - AVE)	0.057	0.044	0.037	0.043	0.042
SD	0.095	0.075	0.060	0.067	0.073
Minimum	0.641	0.643	0.755	0.709	0.647
Maximum	1	1	1	1	1
No. of Efficient Banks (%)	23(64%)	22(61%)	22(61%)	22(61%)	21(58%)
Scale Efficiency (SE)					
No. of Banks	36	36	36	36	36
Average Efficiency (AVE)	0.972	0.963	0.974	0.972	0.978
Average Inefficiency (1 - AVE)	0.028	0.037	0.026	0.030	0.022
SD	0.057	0.058	0.054	0.050	0.049
Minimum	0.702	0.736	0.733	0.783	0.735
Maximum	1	1	1	1	1
No. of Efficient Banks (%)	15(42%)	15(42%)	17(47%)	14(39%)	16(44%)

Overall Technical Efficiency (OTE) -

Average OTE during study period is 93.4 % showing that the Indian banks are quite technically efficient. Therefore, the study reveals that the mean efficiency score of Indian domestic commercial banks compares very well with the world mean efficiency scores of 86% as per Berger and Humphrey[2] (1997). Though they also pointed out that cross-country efficiency estimates need to be interpreted with caution because of the differences in regulatory framework, economic environment etc. This high OTE scores support the hypothesis of high competition in the Indian banking industry. The mean OTE (93.4%) suggests that inefficiency in resource utilization of the Indian banks is 6.6% implying that Indian banks (based on sample) could have saved 6.6% of present level of inputs used to produce present level of outputs i.e., if utilizing inputs on the efficient frontier instead of its current location, would decrease on an average 6.6% of inputs currently being used. Alternatively Indian banks have the scope of producing 7 % (1/.934) more outputs than the present outputs produced from the same level of inputs currently utilized.

Figure: 5.2

Trend of Overall Technical Efficiency



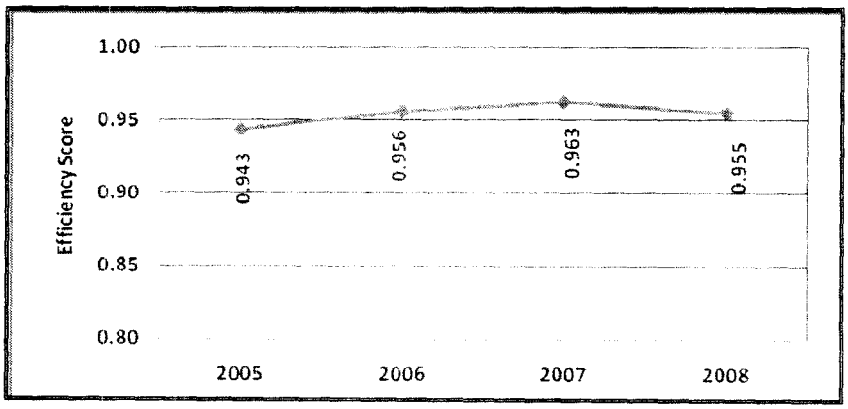
From the Figure: 5.2, it is observed that OTE is increasing in trend during the study period. The results also indicate that there is still asymmetry between Indian banks as regards their OTE that ranges between 56.15% (lowest in 2006) and 100%. But it is to be pointed out that this asymmetry is decreasing in trend, which is also evidenced from the SD of OTE score reducing from .104 to .084. It is also observed that 44% of the sample banks are 100% globally technical efficient during study time.

Pure Technical Efficiency (PTE)

Theoretically OTE ≤ PTE, this is not exceptional in my study but the pure technical efficiency (PTE)) of the Indian banks are much more than OTE both in terms of average (95.8%) and number of fully efficient banks (21banks i.e. 58% of the sample banks) during study period. Asymmetry with regard to PTE as expected but to a great extent is low in comparison to OTE (PTE ranging between 64.1% (lowest in 2006) and 100% with SD ranging between 9.5% and 6%). Increasing trend of managerial performance of the Indian banks is also found over the study period.

Figure: 5.3

Trend of Pure Technical Efficiency

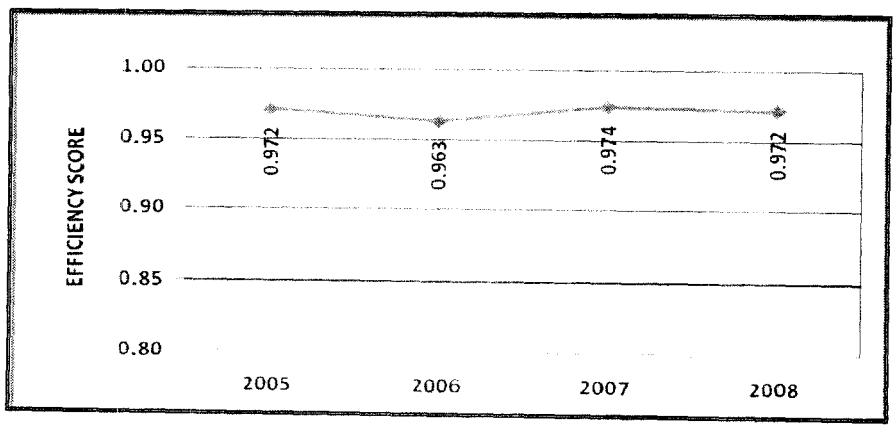


Scale Efficiency –

Most of the Indian banks as represented by the sample banks have been experiencing higher scale efficiency (97.8%) than PTE (95.8%).

Figure: 5.4

Trend of Scale Efficiency



Mean Scale efficiency over the study period is stable with lowest asymmetry ranging between .702 (lowest in 2005) and 1 and SD ranging between .058 and .050 compare to that of OTE and PTE.

From the above generalized analysis of DEA efficiencies, two important findings /observations are made.

The first observation is that average OTE **(93.4%)** of the Indian banks is not as high as it should be from the higher average PTE **(95.8%)** as well as SE **(97.8%).** The possible reason is that the some banks under study have higher pure technical efficiency but their scale efficiency is poor, on the other side some other banks which have higher scale efficiency are having lower pure technically efficiency. So majority of the inefficient banks (by CCR efficiency) are facing a large difference between pure technical efficiency and scale efficiency which may not increase OTE level more than 93.4%.

Secondly, this study supports the hypothesis that the performance of the banking relates to the economy strength and banks are getting the advantage of economies of scale during strong economy. In 2006-07 when Indian economy touched the highest GDP growth rates of about 9.6%, most of the Indian banks have reached to the highest score of all these three types of efficiency during the study period. It is also noticeable that in 2007-08 when GDP growth rate has gone down from 9.6% to 9 %[3]. movement of all these efficiencies of most of the banks has also gone down from those of 2006-07. This is reflected in the lower average score of all efficiency types in 2007-08 in comparisons to 2006-07 which again prove that the performance of the banking depends to the economy strength.

5.2.2: Efficient and Inefficient Banks

Specialty of the DEA methodology is to discriminate the DMUs (banks) into efficient (efficiency score = 1 or 100%) and inefficient (efficiency score < 1) status. Thus, in this section, we segregate the 36 selected banks into efficient and inefficient banks based on CCR and BCC efficiency scores. Banks are categorized into three groups

CCR and BCC efficient (OTE = PTE =1)

BCC efficient but not CCR efficient (PTE = 1 but OTE <1)

CCR and BCC inefficient (OTE & PTE < 1)

Table 5.4 provides the list of efficient and inefficient banks in terms of above mentioned three categories.

Table: 5.4

List of Efficient and Inefficient Banks

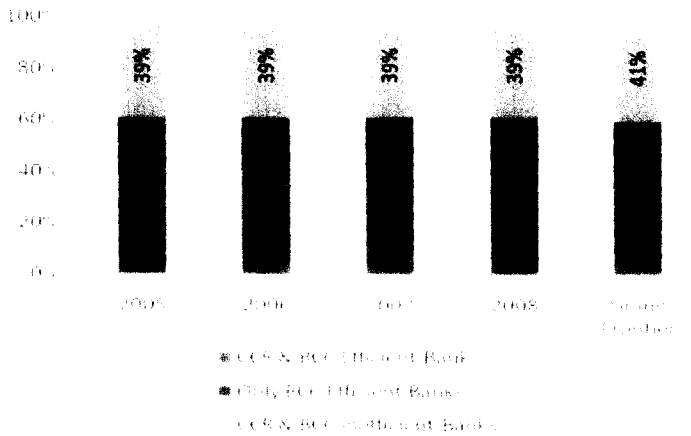
C-I	C-II	C-III	C-I	C-II	C-III	C-I	C-II	C-III	C-I	C-II	C-III	C-I	C-II	C-III
2005			2006			2007			2008			Grand Frontier		
ANB	CAB	ALB	CAB	ALB	ANB	ALB	CAB	ANB	ALB	BOI	ANB	COB	PNB	ALB
COB	IOB	BOI	COB	IOB	BOB	COB	PNB	BOB	COB	CAB	BOB	IDL	SBI	ANB
IDL	PNB	***BOB***	IDL	PNB	BOI	IDL	SBI	BOI	IDL	IOB	BOM	IOB	SBJ	BOB
OBC	SBI	BOM	OBC	SBI	BOM	IOB	DLB	BOM	OBC	PNB	DEB	OBC	CAB	BOI
UBI	DLB	DEB	UBI	SBM	***DEB***	OBC	IIB	DEB	SBT	UBI	SYB	UBI	DLB	BOM
VJB	JKB	SYB	SBJ	DLB	SYB	UBI		SYB	CUB	SBI	UCB	SBT		DEB
SBJ	AXB	UCB	SBT	IIB	UCB	SBT		UCB	FDB	DLB	VJB	CUB		SYB
SBT	CBP	SBM	CUB		VJB	CUB		VJB	JKB	LVB	SBJ	FDB		UCB
CUB		BOR	JKB		BOR	FDB		SBJ	KVB		SBM	JKB		VJB
KTB		FDB	KTB		FDB	JKB		SBM	AXB		BOR	KTB		SBM
KVB		IVB	KVB		IVB	KTB		BOR	HDB		IVB	KVB		BOR
HDB		***LVB***	AXB		***LVB***	KVB		IVB	ICB		KTB	AXB		CBP
ICB		SIB	HDB		SIB	AXB		***LVB***	IIB		SIB	HDB		IVB
IIB			ICB		CBP	CBP		SIB	KMB		***CBP***	ICB		LVB
KMB			KMB			HDB						IIB		SIB
						ICB						KMB		
						KMB								

Note: C-I = CCR and BCC efficient; C-II = BCC efficient but not CCR efficient C-III = CCR and BCC inefficient. Banks are arranged as per order of ownership group.

From the Table: 5.4 we calculate the number of banks belonging to these categories. Year wise numbers of banks under the three categories are found to be more or less same in all the years under study (Figure: 5.5).

Figure: 5.5

Number of Efficient & Inefficient Banks (%)



Over the study period (grand frontier), about 45% banks are found to be both CCR and BCC efficient. They are also called as globally efficient banks in DEA literature. They are actually technically and scale efficient (PTE = SE = 1) banks. Thus 55% banks are globally inefficient or CCR inefficient having OTE< 1. Out of these 55%, 14% are BCC efficient but not CCR efficient i.e. only locally efficient banks and remaining 41% banks are CCR and BCC inefficient i.e. locally inefficient banks (OTE & PTE< 1). All the globally efficient banks are also locally efficient or BCC efficient ones. Thus, there are 58 % (44%+14%) banks locally or BCC efficient banks. Similar explanation is for yearly results.

From the above list of efficient and inefficient banks, the study also reveals that out of 36 banks, there are 9 top performing banks and 9 least performing banks which are efficient and inefficient in all the years under study both in terms of OTE and PTE respectively.

Table: 5.5

List of Top and Least Performing Banks during the Study Period

Top Performing Banks (OTE=PTE = 1)	COB, IDL, OBC,SBT,CUB, KVB, HDB, ICB, KMB
Least Performing Banks (OTE & PTE < 1)	BOB, BOM, DEB, SYB, UCB, BOR, DLB*, IVB, SIB

**DLB is included in the least performing banks group since its pure technical efficiency score of 100% is caused by its use of smallest amount of inputs. It is actually a least performing bank throughout the study time. Its OTE is also very poor relative to other least performing banks listed above.*

5.2.3: Decomposition of Technical Efficiency

There is a relation among these three types of DEA efficiencies – OTE, PTE and SE. This relationship is popularly known as decomposition of efficiency in DEA literature. Following relationship demonstrates a decomposition of efficiency.

OTE = PTE × SE

[OTE – Overall Technical Efficiency measured by CCR Model, PTE – Pure Technical Efficiency by BCC model and SE – Scale Efficiency measured by OTE/ PTE.]

From this efficiency equation OTE is always less than or equal to PTE. The equality holds when the scale efficiency is one or 100%. BCC technique gives maximum efficiency score while CCR technique minimum efficiency scores. This decomposition depicts the sources of inefficiency i.e., whether inefficiency of a DMU is caused by inefficient operation (PTE) of the DMU itself or by the disadvantageous conditions under which the DMU is operating. Technical inefficiency of the Indian banks is found to be caused by both pure technical inefficiency (PTIE) and scale inefficiency (SIE). But it is observed that the main source of inefficiency of Indian banking is pure technical inefficiency (PTIE) since SE is more than PTE throughout the study period as evidenced from lower mean and higher standard deviation of PTE (95.8%, 7.3%) compared to that of SE (97.8%, 4.9 %). So, pure technical inefficiency contributes more towards overall technical inefficiency. But this contribution of pure technical inefficiency over scale inefficiency is not high as because the mean score difference between PTE and SE is only 2%. In other words Scale efficiency contributes more towards overall technical efficiency. Therefore possible OTE improvement can be achieved more by improving PTE rather improving SE since mean scale inefficiency (SIE) of 2.2% is lower compared to the mean pure technical inefficiency 4.2%. This finding was reported in several studies for other countries as well as in India. Such studies include Aly[4] *et al.* (1990) for US banking, Fukuyama[5] (1993) for Japanese banks, and Zaim[6] (1995) for Turkish banking, Noulas and Ketkar[7] (1996), Kumar and Gulati[8] (2009) for Indian banking.

Based on the concept of decomposition of technical efficiency, banks are divided into three categories as under in order to find further insights.

Category I -Banks with PTIE=SIE=0, i.e., PTE = SE=1

Category II-Banks with PTIE < SIE i.e., PTE> SE and

Category III- Banks with PTIE > SIE i.e., PTE< SE

By this category, this section helps to identify bank wise main source of inefficiency in resource utilization whether caused by inefficient management or disadvantageous condition under which they are operating. Banks of category I is nothing but the globally efficient banks (OTE = 1) and banks of category II & III are globally inefficient banks or CCR inefficient banks (OTE<1).

Table: 5.6

Bank-wise Main Source of Inefficiency as per Grand Frontier result

Category-I (PTIE=SIE=0)				Category-II (PTIE< SIE)				Category-III (PTIE> SIE)			
Banks	OTIE	PTIE	SIE	Banks	OTIE	PTIE	SIE	Banks	OTIE	PTIE	SIE
COB	0	0	0	ANB	0.087	0.032	0.057	ALB	0.07	0.049	0.022
IDL	0	0	0	BOB	0.162	0.082	0.088	BOM	0.142	0.128	0.016
IOB	0	0	0	BOI	0.15	0.07	0.086	DEB	0.126	0.114	0.014
OBC	0	0	0	CAB	0.038	0	0.038	SBM	0.054	0.028	0.026
UBI	0	0	0	PNB	0.001	0	0.001	SYB	0.178	0.147	0.037
SBT	0	0	0	SBI	0.097	0	0.097	UCB	0.162	0.141	0.025
CUB	0	0	0	SBJ	0.017	0	0.017	VJB	0.056	0.055	0.001
FDB	0	0	0	DLB	0.265	0	0.265	BOR	0.354	0.353	0.002
JKB	0	0	0	LVB	0.106	0.044	0.065	IVB	0.14	0.134	0.006
KTB	0	0	0	CBP	0.057	0.026	0.032	SIB	0.117	0.117	0
KVB	0	0	0								
AXB	0	0	0								
HDB	0	0	0								
ICB	0	0	0								
IIB	0	0	0								
KMB	0	0	0								
Average	**0**	**0**	**0**	**Average**	**0.098**	**0.025**	**0.074**	**Average**	**0.139**	**0.126**	**0.014**

Table: 5.6 shows that banks of category-I which are nothing but 100% CCR efficient have no inefficiency (PTIE = SIE = 0). Banks of category II & III are CCR inefficient. Inefficiency of category II is primarily caused by disadvantageous condition under which they are operating while category III by inefficient management. Table 5.5 shows that 4 banks viz. CAB, PNB, SBI and SBJ of Category II are 100% efficient in management (PTE =1). Therefore, their overall technical inefficiencies are only attributed to disadvantageous conditions under which they are operating. SBI has the highest SIE (9.7%) among the banks of category II (not considering DLB) followed by BOB (8.8%), BOI (8.7%). Other banks of Category II have very marginal SIE. PNB is very close to 100% SE. whereas, BOM, SYB, UCB, BOR and IVB in category III have PTIE more than 12% i.e. suffering from managerial underperformance.

With this analysis, over the study period, this study finds that 16 banks out of 36 banks under study of category I i.e., 44% of the sample banks are 100% technical and scale efficient (i.e. PTE = SE = 1 and OTE = 1). Inefficiencies of 10 banks of category II (28% of the sample banks) are caused mainly by their operations with inappropriate size rather than managerial inefficiency as evidenced from the mean SIE which is more than PTIE by 4.9% (7.4% - 2.5%). Inefficiencies of other 10 banks with category III (28% of the sample banks) are caused primarily by their inefficient operations or management rather than scale inefficiency since PTIE is more than SIE by 11.2% (12.6% - 1.4%). So, it is find out that 50% of the CCR inefficient banks are suffering from scale inefficiency and 50% from managerial inefficiency.

From table 5.6 it is also find out that OTIE of category II (9.8%) is much lower than that of category III (13.9%). Thus, the banks which are suffering mainly from scale inefficiency have higher OTE than those of the banks suffering mainly from managerial inefficiency. So the earlier observation of higher contribution of pure technical inefficiency towards overall technical inefficiency is primarily responsible for the banks under category III (PTIE > SIE). And this contribution is not to a great extent because 50% of the CCR inefficient banks are with PTIE < SIE and remaining 50% are with PTIE > SIE.

Again from the decomposition of efficiency point of view, it is clearly viewed that the Indian inefficient banks are facing the problem of mismatch between PTE and SE. 50% of the inefficient banks have higher PTE than SE by about 4.9%, while remaining 50% have higher SE than PTE by about 11.2%. This highly mismatch between PTE and SE of the inefficient banks can not increase mean OTE of all banks under study beyond 93.4%. This finding proves the previous observation that average OTE **(93.4%)** of the Indian banks is not as high as it should be from the higher average PTE **(95.8%)** as well as SE **(97.8%).**

5.2.4 Efficiencies and Returns to Scale

Scale inefficiency appears to affect the overall inefficiency of Indian banks. It is worthwhile to examine their returns to scale. Therefore, the issue of scale inefficiencies is explored with greater detail by considering returns-to-scale (RTS) properties of the individual banks. This section shows that whether Indian banks are enjoying economics of scale or facing the problem of diseconomies of scale. This section also identifies that which banks should go for scaling up or scaling down their activities to improve overall technical efficiency. In production theory, the change in output levels due to changes in input levels is termed as returns to scale (RTS).

Obviously, there are three possible cases:

- Increasing returns to scale (IRS) occur when one percent increase in inputs produces more than one percent increase in outputs.
- Constant returns to scale (CRS) occur when one percent increase in inputs results in exactly one percent increase in outputs.
- Decreasing returns to scale (DRS) happen when one percent increase in inputs leads to less than one percent increase in outputs.

BCC and CCR model identify the returns to scale characteristic of the individual DMUs. The study has followed the CCR model to determine the nature of returns to scale of the banks following the theorem of Banker and Thrall[9] (1992). Employing the CCR

envelopment model to obtain an optimum solution (λ_j), returns to scale can be determined from the following conditions

$\sum_{j=1}^{n} \lambda_j = 1$ in any alternate optimum then constant return to scale prevails.

$\sum_{j=1}^{n} \lambda_j > 1$ in all alternate optimum then decreasing return to scale prevails.

$\sum_{j=1}^{n} \lambda_j < 1$ in all alternate optimum then increasing return to scale prevails.

Banker and Thrall (1992) proved this theorem on the assumption that DMU is on the efficient frontier. However, numerous studies in DEA literature attended to the identification of scale economics. [Bankers et al.[10] (1984), Ray[11] (2005) and Tone[12] (1996).]

This study mentions bank wise nature of returns to scale (RTS) properties (i.e., whether banks are operating under DRS, IRS or CRS) as identified by the theorem of Bankers and Thrall based on CCR projected activities. Nature of returns to scale of the individual banks is provided in Annexure: 5. (D).

It is observed that there are some banks which are operating at same scale throughout the study period. COB, IDL, OBC, SBT, CUB, KVB, HDB, ICB and KMB are found to be operating at region where constant returns to scale prevails whereas, BOB, BOI, BOM, PNB, SYB, SBI at decreasing returns to scale and BOR, DLB, IVB, LVB at increasing returns to scale. All other 18 banks are changing their nature of scale of operation during the study period. ALB, one of them is operating at DRS in 2005 and 2006 but at CRS in 2007 and 2008. But this bank is operating at DRS over the study period as a whole (based on the grand frontier). This finding indicates that ALB is gradually moving at the right scale of operation. Like ALB banks other banks e.g. DEB,

IOB, VJB, SBJ, FDB are tending to fluctuate their nature of scale over the study period and hence operate at high scale efficiency.

Returns to scale analysis suggest that globally efficient banks are 100% scale efficient and globally inefficient banks are operating in the region where IRS or DRS prevails. Banks with IRS have the possibility to improve their efficiency by scaling up their activities, whereas banks with DRS scaling down the operation to gain efficiency (OTE).

Table: 5.7

Number of Banks in % under various Returns-to- Scale

	CRS	DRS	IRS
2005	42%	36%	22%
2006	42%	39%	19%
2007	47%	31%	22%
2008	39%	31%	30%
Grand Frontier	45%	44%	11%

Note % is calculated on total number of banks in the sample i.e. 36

As per Table: 5.7, over the study period 45 percent banks show CRS, 44 percent DRS and only 11 percent IRS in their production technologies. It is pointed out here that as per the theorem of Ahn et. al.[13] (1989), a DMU is operating at most productive scale size (MPSS) if the DMU is found to be efficient with CCR model and with corresponding BCC model and constant returns-to scale prevails at that DMU. Accordingly, 45% of the Indian banks (based on sample) are operating at MPSS.

44% of the sample banks are facing the problem of scale inefficiency due to DRS or diseconomies of scale implying that they are above their optimal scale i.e. in general they are large. The DRS may arise due to inefficient managerial or labor policies or because of it is costly to manage a very large firm. Therefore, scaling down of their activities seems to be the appropriate strategic option of these banks to improve OTE. BOI, BOB and SBI belonging to DRS are suffering from scale inefficiency largely. Their scale efficiencies are .914, .912 and .902 respectively (from the lowest side). The case of SBI is more serious among them. Therefore, these three banks can also achieve larger increase in OTE by decreasing their size. Here it is to mention that banks with DRS are

operating at disadvantageous condition. Over the study period on an average more than 55% branches of banks with DRS group are located in rural and semi urban areas. But this is only 41% for banks with CRS group and 48% for banks with IRS group. More than 60% (BOB), 64% (BOI) and 69% (SBI) branches are located in rural and semi urban areas. Thus, dominance of banking operation in rural areas may be the major reason for lower scale efficiency of these banks.

11% of the sample banks are scale inefficient as a result of IRS or economics of scale implying that they are operating below the optimal scale i.e. they are small. This means that unit cost of these banks decline when they increase their production volume. This may be due to fixed nature of inputs cost. Significance of this finding is that these banks can enhance OTE by increasing their size.

With this analysis the study has found that majority banks have been experiencing constant returns to scale (CRS) in their operations during all the years under study. Over the study period, 45% banks are operating at most productive scale size where CRS prevails. Besides, about 14% banks (viz. DEB, VJB, BOR, OVB, SIB) which are operating at DRS or IRS are very close to 100% scale efficiency. These findings indicate that most of the Indian banks are operating at correct scale. Therefore, there is a little scope of improvement of OTE by eliminating scale inefficiency of the Indian banks. This observation supports the earlier findings that pure technical inefficiency is the main source of inefficiency.

During the four years study period (2004-05 to 2007-08) India has witnessed a strong and stable economy with average GDP growth rate 9%. During this period most of the banks are scale efficient. In the earlier section it has been found also that most of the inefficient banks have lower SIE than PTIE during all the years under study. The year 2006-07, when Indian economy has touched highest GDP growth rate (9.6%), has witnessed the highest scale efficiency by the Indian banks with maximum number of banks belonging to CRS (47% of the sample banks) and out of 31% at DRS, 13 % banks are very close to 100% scale efficiency. These findings support the hypothesis that banks are getting the advantage of economies of scale i.e. higher scale efficiency during strong economy.

Another observation is that number of banks with DRS is more than that of IRS throughout the study period. Thus, DRS is observed to be the predominant form of scale inefficiency in India.

5.2.5: Strength of Efficiency Analysis: Efficient Banks

The banks which provide the best practice of input utilization or efficient frontier form a reference set of the inefficient banks. In DEA literature these banks are called peer banks and inefficient banks should follow their good operating practice to improve their efficiency. The reference set i.e., peer group is a set of efficient units to which an inefficient unit has been most directly compared when calculating its efficiency rating. It contains the efficient units which have the most similar input/output orientation to the inefficient unit and should therefore provide examples of good operating practice for the inefficient unit to emulate.

Reference set for inefficient DMUs may differ from DMU to DMU.

DMU(s) which have $\lambda_j > 0$ form the reference set (R) of an inefficient DMU in CCR & BCC models.

$R_k = \{j / \lambda_j > 0\}$ $(j \in \{1 \ldots\ldots\ldots n\})$[14]

Higher the lambda value of an efficient DMU in a reference set greater is the similarity of such efficient DMU to the inefficient DMU compared to the other efficient DMUs in that reference set.

Magnitude of frequency in reference sets measures the extent of robustness of efficient banks relative to other efficient banks. In other words, higher the frequency the more robust is. The banks which appear frequently in the reference set of inefficient banks are the banks which are likely to remain efficient unless there are major shift in their fortunes. These banks may be termed as 'well round performer' or 'global leader'[15]. Efficient banks that appear seldom in the reference sets of inefficient banks are like to possess a very uncommon input and output mix and thus they are not good examples of operating practice to emulate for inefficient banks. Thus they are 'marginally efficient banks'. Efficient banks with zero frequency are termed as 'efficient by default' in DEA

terminology because they are somewhat odd or peculiar institution with characteristics. So, inefficient banks should not follow them to improve their efficiency.

Table: 5.8

Frequency in Reference Sets of Efficient Banks as per CCR model

SN	Banks	2005	2006	2007	2008	Grand frontier
1	**COB**	**13**	**5**	**0**	**1**	**4**
2	**IDL**	**5**	**5**	**8**	**8**	**6**
3	**OBC**	**4**	**6**	**1**	**1**	**3**
4	**SBT**	**3**	**0**	**11**	**15**	**10**
5	**CUB**	**4**	**14**	**2**	**3**	**13**
6	**KVB**	**1**	**14**	**12**	**3**	**10**
7	**HDB**	**9**	**14**	**8**	**5**	**5**
8	**ICB**	**1**	**3**	**3**	**10**	**4**
9	**KMB**	**8**	**6**	**8**	**9**	**10**
10	ALB	IE	IE	0	0	IE
11	CAB	IE	0	IE	IE	IE
12	IOB	IE	IE	3	IE	0
13	UBI	8	1	6	IE	1
14	VJB	3	IE	IE	IE	IE
15	SBJ	12	6	IE	IE	IE
16	FDB	IE	IE	5	17	1
17	JKB	IE	0	3	4	0
18	KTB	0	3	0	IE	0
19	AXB	IE	1	3	0	0
20	CBP	IE	IE	0	IE	IE
21	IIB	3	IE	IE	1	0
Average Frequency		4.9 ≈ 5	5.2 ≈ 5	4.2 ≈ 4	5.5 ≈ 5	4.2 ≈ 4

Note- IE- Inefficient (OTE < 1) in that year. 2005-08 based on grand frontier result

Table 5.8 shows the year wise frequency count of the individual efficient banks. Banks which are efficient in all the years of study (serial no 1 to 9) are placed in the upper side of this table. This table clearly indicates bank wise strength of the efficiency as measured by the frequency count. A closer examination of Table 5.8 reveals that the IDL and KMB are mostly stable so far as robustness of efficiency is concerned and their trend of efficiency strength is increasing over the years. HDB is stable but it is slightly decreasing in trend during study period. SBT is stable with increasing trend except 2006. COB, OBC, UBI, SBJ and CUB are inconsistent in their robustness of efficiencies and

their strength of efficiency is in decreasing trend during study period. ICB which have very low frequency in reference set in 2005 to 2007 has reached to the third position of the robustness of efficiency in 2008 as per frequency count after SBT and FDB.

If we look into the banks with serial No. 10 to 21, we can see that most of the banks have low frequency even with zero frequency and they are efficient in only one or two years out of four years of study. This finding indicates that the efficient banks with low frequency in reference set have lower stability in 100% efficiency status. ALB, CAB, VJB, AXB, CBP and IIB are the banks with low frequency in reference set during the study period. They are actually weak efficient banks i.e. strength of their efficiency is low. They would likely to drop from the efficient frontier if there is even a small increase (decrease) in the value of any input (output) variables. It is also further observed that the banks with a very higher frequency in reference sets in a particular year do not drop out from the efficient frontier in the next year. They are in the efficient banks group with at least a low frequency in the next year. It is clearly visible in case of COB and SBJ from 2005 to 2006, CUB from 2006 to 2007 and KVB from 2007 to 2008. Therefore, the chance of losing 100% efficiency status of banks with low or zero frequency in reference sets is very high compared to banks with higher frequency in reference sets.

Frequency in reference sets discriminates efficient banks as proposed by Chen[16], (1997) and Chen and Yeh[17] (1998) and helps to rank them. Average frequency (Table: 5.8) over the study period is 4 to5. On the basis of frequency level in reference sets, efficient banks may be categorized as follows -

I) Highly Efficient Banks (more than equal to average frequency i.e. $f \geq 5$)

II) Efficient banks (less than average frequency i.e. $f < 5$)

III) Efficient by default (frequency = 0)

Table: 5.9

Categories of Efficient Banks by Frequency count in Reference Set

Year	2005		2006		2007		2008		Grand Frontier	
Category	N	Banks	N	Banks	N	Banks	N	Banks	N	Banks
Highly Efficient Banks (f ≥ 5)	6	COB,IDL, UBI,SBJ,HDB ,KMB	6	IDL, SBJ, CUB,KVB, HDB, KMB	7	IDL,UBI, SBT,KVB, FDB,HDB, KMB	6	IDL,SBT,,FDB,ICB,HDB,KMB	6	IDL,SBT, CUB, KVB,HDB,KMB
Efficient Banks (f <5)	8	ANB,OBC,VJB,SBT,CUB ,KVB, ICB,IIB	6	COB,,OBC, UBI, KTB,AXB,ICB,	6	IOB,,OBC, CUB,JKB, AXB,ICB,	6	COB,OBC, CUB,JKB, KVB,IIB	5	COB,OBC,UBI, FDB, ICB
Efficient by default (f =0)	1	KTB	3	CAB,SBT,JKB	4	ALB,COB, KTB,CBP	2	ALB,AXB,	5	IOB,JKB, KTB,AXB, IIB

Note: N – number of banks within a group, banks are listed in each group according to ownership pattern -NB, SB, OPB and then NPB.

From the table 5.9, only three banks – IDL, HDB and KMB are in the highly robust banks group in all the years. ALB, CAB, CBP are in the 'efficient by default' group while AXB which is very renowned new private bank is weakly efficient and is placed in 'efficient' and 'efficient by default' banks group during the study time. However, during the study period, out of 16 CCR efficient banks (by grand frontier), six banks are highly efficient banks, 5 banks are efficient and 5 banks are efficient by default.

So from analysis of the frequency in reference sets, it can be easily predicted that IDL, SBT, CUB, KVB, HDB and KMB can be able to maintain their 100% efficiency position in future unless there are major shift in their fortunes. At the same time IOB, JKB, KTB, AXB, IIB may strike out from the efficient frontier in the coming years as indicated by their zero frequency in reference set unless there is a substantial improvement in their operations.

5.2.6: Improvement of Efficiency Analysis: Inefficient Banks

Earlier section deals with only fully CCR efficient banks and discriminates them into three groups based on the frequency of reference sets. This section of analysis deals with only CCR inefficient banks.

5.2.6.1: Categories of Inefficient Banks

Before discussing improvement of efficiency plan of inefficient banks to become fully efficient, an attempt is made to segregate the inefficient banks (OTE<1) into three groups based on the OTE scores distribution. This segregation helps to find better insights into improvement of efficiency plans.

Table: 5.10

Categories of Inefficient Banks by CCR scores

Year		2005	2006	2007	2008	Grand Frontier
Category		Banks	Banks	Banks	Banks	Banks
Marginally Inefficient (.90 - <1)	Banks	CTB,JKB,SBM,IOB,LVB,,PNB,AXB	IOB,FDB,PNB,SBM,VJB,SBI,IIB,IVB,DEB,ALB	IIB,CAB,PNB,SBJ,VJB,DEB,SBM,LVB,IVB	UBI,IOB,PNB,VJB,BOI,CAB,SBJ,SIB,KTB,BOM	PNB,SBJ,CAB,SBM,VJB,CBP,ALB,SBI
	N	7	10	9	10	9
	MS	0.95	0.94	0.95	0.95	0.95
Inefficient (.80 - <.9)	Banks	CAB,FDB,SBI,BOB,ALB,SYB,IVB	ANB,BOM,SYB,SIB,CBP,BOB	SIB,ANB,BOM,UCB,SBI,BOB,SYB,BOI	ANB,LVB,SBI,SYB,SBM,CBP,IVB,DEB,UCB,BOB	LVB,SIB,DEB,IVB,BOM,BOI,BOB,UCB,SYB
	N	7	6	8	8	9
	MS	0.87	0.87	0.85	0.85	0.86
Distinctively Inefficient (<.80)	Banks	SIB,UCB,DEB,BOI,BOM,DLB,BOR	UCB,LVB,BOI,DLB,BOR	BOR,DLB	DLB,BOR	DLB,BOR
	N	7	5	2	2	2
	MS	0.74	0.73	0.74	0.73	0.69

Note: N = No of Banks belonging to the group, MS = Mean Score (OTE) of the respective groups, Banks are listed in each group according to descending order of OTE scores

The marginally inefficient banks will have an efficiency rating in excess of 0.9 but less than 1 and could raise their score towards 1.0 with a relatively small amount of improvement in their operating results. Banks of this category can reach the efficient frontier by making radial reduction on an average 5% (1-.95) of the inputs they currently use. Medium inefficient banks that have efficiency score between 0.8 and 0.9 can lie on the efficient frontier through radial reduction on an average 14% of their current inputs level. Distinctively inefficient banks that have efficiency score of less than 0.8 would have significant difficulties making them efficient in the short term. Banks of this group are required to reduce current input usage by 31% which is much higher than that of other two groups.

With this analysis it is observed that marginally inefficient banks can attain the 100% efficient status by a little improvement in resource utilization. Banks of category II and then III are the worst performers in the sample and may be considered as 'target banks' in the recapitalization and the consolidation scheme that have been taken place in Indian banking sector. Therefore, the regulators must pay attention to enhance their efficiency level which ultimately will increase the overall efficiency position of the Indian banks. We further observe that the number of banks belonging to distinctively inefficient category is decreasing steadily while it is increasing in case of marginally inefficient banks during study time. On the whole, distribution of efficiency score is skewed towards the higher efficiency score.

5.2.6.2: Input-output Improvement Plan

As already discussed in the methodology chapter, there are two sources of inefficiencies: *purely technical inefficiency*[18] *(PYTIE)* represented by radial measure (1-efficiency score obtained) and *mix inefficiency (MXIE)* represented by the input and output non-zero slacks.

Linear programming based DEA technique provides zero and non zero input and output slacks corresponding to input output constraints. In DEA, zero input and output slacks exist for both efficient and inefficient DMUs. But non zero input and output slacks

exist only for the inefficient DMUs. An inefficient DMU becomes efficient by improving its input and output. This can be calculated from both the CCR & BCC models as follows

Input reduction i.e. Input improvement = Actual Input values x (1 – efficiency score obtained) + Input Excess/ Input Slack if any.

Output augmentation / output improvement = Output shortfall (slack) if any.

Hence, an inefficient DMU can be efficient by achieving input and output target which is calculated as follows-

Input Target = Actual Input - Input improvement = Actual Input * Efficiency score - Input Excess (Slack)

Output Target = Actual Output + Output improvement = Actual Output + Output shortfall (slack).

This input and output target i.e. improvement plan is called in DEA literature as projection. This projection shows how an inefficient bank becomes fully efficient by indicating the level of inputs to be utilized and level of outputs to be produced. Table 5.10 shows the CCR projection i.e., input output improvement plan which would make inefficient banks efficient ones.

Input projection (%) = Input Improvement/ Actual Input used × 100.

Output Projection (%) = Output Improvement / Actual Output produced × 100.

Input projection is presented with a negative sign and output projection with positive sign as because of inputs to be reduced and output to be enhanced for efficiency improvement philosophy.

Table: 5.11

Inefficient Bank wise Input-output Improvement Plan

SN	DMU	ES	Inputs								
			RAP (1-MS)	I (No of Branches)		II (No of Employees)		II (Operating Expenses)		IV (Deposit)	
				SAP	T P	SAP	T P	SAP	T P	SAP	T P
1	ALB	93.0%	7.0%	-28.6%	-35.6%	0.0%	-7.0%	0.0%	-7.0%	0.0%	-7.0%
2	ANB	91.3%	8.7%	-17.5%	-26.2%	-3.5%	-12.2%	0.0%	-8.7%	0.0%	-8.7%
3	BOB	83.8%	16.2%	0.0%	-16.2%	-5.8%	-22.0%	0.0%	-16.2%	0.0%	-16.2%
4	BOI	85.0%	15.0%	0.0%	-15.0%	-13.2%	-28.2%	0.0%	-15.0%	0.0%	-15.0%
5	BOM	85.8%	14.2%	-21.8%	-36.1%	-4.0%	-18.3%	0.0%	-14.3%	0.0%	-14.3%
6	CAB	96.2%	3.8%	0.0%	-3.9%	-8.8%	-12.7%	0.0%	-3.9%	-6.9%	-10.8%
7	DEB	87.4%	12.6%	-32.7%	-45.3%	-13.2%	-25.8%	0.0%	-12.6%	0.0%	-12.6%
8	PNB	99.9%	0.1%	-13.0%	-13.2%	-16.9%	-17.0%	-3.0%	-3.2%	0.0%	-0.1%
9	SYB	82.2%	17.8%	-0.3%	-18.2%	0.0%	-17.8%	0.0%	-17.8%	0.0%	-17.8%
10	**UCB**	**83.8%**	**16.2%**	**-17.9%**	**-34.1%**	**-6.8%**	**-23.0%**	**0.0%**	**-16.3%**	**-7.1%**	**-23.3%**
11	VJB	94.4%	5.6%	-45.3%	-50.9%	0.0%	-5.6%	0.0%	-5.6%	-0.5%	-6.1%
12	SBI	90.3%	9.7%	-16.5%	-26.3%	-27.9%	-37.6%	0.0%	-9.7%	0.0%	-9.7%
13	SBJ	98.3%	1.7%	-23.6%	-25.3%	-16.3%	-18.0%	0.0%	-1.7%	0.0%	-1.7%
14	SBM	94.6%	5.4%	-31.6%	-36.9%	-27.9%	-33.3%	0.0%	-5.4%	0.0%	-5.4%
15	BOR	64.6%	35.4%	-19.9%	-55.3%	-2.7%	-38.2%	0.0%	-35.5%	0.0%	-35.5%
16	DLB	73.5%	26.5%	-41.8%	-68.3%	-8.4%	-35.0%	0.0%	-26.5%	0.0%	-26.5%
17	IVB	86.0%	14.0%	-10.0%	-24.0%	0.0%	-14.0%	-18.7%	-32.7%	0.0%	-14.0%
18	LVB	89.4%	10.6%	-41.7%	-52.4%	-10.1%	-20.7%	0.0%	-10.6%	0.0%	-10.6%
19	SIB	88.3%	11.7%	-31.5%	-43.2%	0.0%	-11.7%	0.0%	-11.7%	0.0%	-11.7%
20	CBP	94.3%	5.7%	-65.8%	-71.5%	-68.0%	-73.7%	-18.2%	-23.9%	0.0%	-5.7%

SN	DMU	ES	Outputs								
			RAP	I (Net Interest Income)		II (Non-interest Income)		III (Priority Sector Advance)		IV (Net Profit)	
				SAP	T P	SAP	T P	SAP	T P	SAP	T P
1	ALB	93.0%	0.0%	2.5%	2.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2	ANB	91.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.8%	0.0%	0.0%
3	BOB	83.8%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%	7.8%	13.2%	13.2%
4	BOI	85.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	1.9%	0.0%	0.0%
5	BOM	85.8%	0.0%	0.0%	0.0%	52.8%	52.8%	0.0%	0.0%	7.7%	7.7%
6	CAB	96.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.3%
7	DEB	87.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.5%	5.5%
8	PNB	99.9%	0.0%	0.0%	0.0%	35.1%	35.1%	6.4%	6.4%	0.0%	0.0%
9	SYB	82.2%	0.0%	0.0%	0.0%	15.2%	15.2%	0.0%	0.0%	17.9%	17.9%
10	UCB	83.8%	0.0%	5.3%	5.3%	10.3%	10.3%	0.0%	0.0%	0.0%	0.0%
11	VJB	94.4%	0.0%	0.0%	0.0%	3.9%	3.9%	0.0%	0.0%	1.9%	1.9%
12	SBI	90.3%	0.0%	0.0%	0.0%	0.0%	0.0%	2.8%	2.8%	0.0%	0.0%
13	SBJ	98.3%	0.0%	5.6%	5.6%	7.0%	7.0%	0.0%	0.0%	0.0%	0.0%
14	SBM	94.6%	0.0%	2.3%	2.3%	0.0%	0.0%	1.3%	1.3%	0.0%	0.0%
15	BOR	64.6%	0.0%	0.0%	0.0%	8.2%	8.2%	22.2%	22.2%	32.7%	32.7%
16	DLB	73.5%	0.0%	0.0%	0.0%	33.4%	33.4%	0.0%	0.0%	1.8%	1.8%
17	IVB	86.0%	0.0%	0.0%	0.0%	12.8%	12.8%	0.2%	0.2%	0.0%	0.0%
18	LVB	89.4%	0.0%	25.5%	25.5%	14.4%	14.4%	0.0%	0.0%	0.0%	0.0%
19	SIB	88.3%	0.0%	0.0%	0.0%	29.8%	29.8%	0.0%	0.0%	7.3%	7.3%
20	CBP	94.3%	0.0%	0.0%	0.0%	0.0%	0.0%	9.7%	9.7%	117.9%	117.9%

Note: ES – CCR efficiency score obtained from grand frontier. RAP = Radial Adjustment Projection, SAP = Slack Adjustment Projection, T P = Total Projection, TP = RAP+SAP for inputs and TP = SAP for outputs.

Table 5.11 determines the way in which each inefficient bank can become DEA efficient. Each inefficient bank can be CCR fully efficient by reducing inputs of the present level by the % mentioned in 'TP' column in input side and enhancing outputs of present level by the % mentioned in 'TP' column in the output side in Table 5.11. Out of total projection in inputs there are two adjustments - one for ***radial adjustment*** (under RAP column which is common for each input of the respective banks) and other for ***slack adjustment*** (under SAP column). Since we follow input oriented model, radial adjustment is not required for outputs produced. Only slack adjustment requires for outputs. Radial adjustment removes purely technical inefficiency (PYTIE) whereas slack adjustment removes mix inefficiency measured by the non-zero slack values of the inputs and outputs if any.

For interpreting the content of Table 5.11, let us consider the case of UCB (UCO Bank).UCB can be 100% CCR efficient through the three phase of input output improvements plan. OTE of this bank is 83.8%

Phase I- It has to reduce its all inputs level by 16.2%.

Phase II – It has to reduce in addition to 16.2% input-I (No of Branches) by 17.9%, input-II (number of employee) by 6.8% and input –IV (deposit) by 7.1%

Phase III- It has to enhance Output I (Net interest Income) by 5.3% and output-II (Non-interest income) by 10.3 %.

Explanation of three phases of input-output improvement:

Phase I- Proportional reduction of each input by 16.2% (100% - 83.8%) removes the purely technical inefficiency of UCB. This is also known as radial adjustment in DEA. By the removal of purely technical inefficiency by reducing 16.2% of each input presently used, the DMU- UCB becomes weakly efficient (fulfill the 'Farrell' or 'week' efficiency, Cooper[18] et al. (2007)).

Phase II – Reduction of another 17.9%, 6.8% and 7.1% of the of the present level input I, II and IV respectively removes the mix inefficiency in respect of presence of non zero slacks of these three inputs .Out of total 34.1 % reduction in the Input –I (number of

branches), 16.2 is required for removing purely technical inefficiency and balance 17.9% for mix inefficiency. Similar explanation is for other two inputs II and IV. No further reduction is required for input III (operating expenses) used by UCB since there is no mix inefficiency for this input i.e. slack values corresponding to this input is nil. Thus the input 'operating expenses' only has the positive impact; whereas present level of 'number of branches', 'number of employees' and 'deposit' have no effect on efficiency evaluation of UCB during the study period.

Phase-III – Enhancement of the level of output-I by 5.3% and output-II by 10.3 % are required to remove mix inefficiency associated with these outputs by the presence of non zero slack values and no enhancement is required for other two output variables as because of zero slacks. Thus, current level of 'net interest income' and 'non-interest income' of UCB has no effect while other outputs play a positive role on the efficiency estimation procedure.

Phase-II & III are known as slack adjustments in DEA (Avkiran[19] (1999); Ozcan[20] (2008). However these slack adjustments in Phase-II & III after radial adjustment in Phase-I makes UCB strongly efficient (fulfill the 'Pareto- Koopmans' or 'strong' efficiency, Cooper[21] et al. (2007)). The similar explanation can also be extended for other inefficient banks. Now we turn to analyze the overall trend of input-output improvement plan or projection of the inefficient banks as a whole based on the mean result of the above CCR projection.

Table: 5.12 show the average input and output improvement of the CCR inefficient banks grouped by public, private and all banks. In order to be 100% efficient, Indian inefficient banks, on an average, need to reduce the use of the each input by 11.9% for radial adjustment and further reduction for input I by 23%, Input-II by 11.7%, input-II by 2 % and input-IV by 0.7% for input slacks adjustments and enhance the outputs – output I by 2.1%, output II by 111%, output III by 2.7% and output IV by 10.3% for output slacks adjustments in comparison to best practices of sample banks.

Table: 5.12

Mean Results of Input-output Improvement Plan grouped by Public and Private and All Banks

Bank group	Average Efficiency	Inputs									
		RAP (1- ES)	I (No of Branches)		II (No of Employees)		II (Operating Expenses)		IV (Deposit)	
			SAP	T P	SAP	T P	SAP	T P	SAP	T P
PUB	90.40%	9.60%	-17.80%	-27.40%	-10.30%	-19.90%	-0.20%	-9.80%	-1.00%	-10.60%
PVT	82.70%	17.30%	-35.10%	-52.40%	-14.90%	-32.20%	-6.20%	-23.50%	-0.00%	-17.30%
ALL	88.10%	11.90%	-23.00%	-34.90%	-11.70%	-23.60%	-2.00%	-13.90%	-0.70%	-12.60%

Bank group	Average Efficiency	Outputs									
		RAP	I (Net Interest Income)		II (Non-interest Income)		III (Priority Sector Advance)		IV (Net Profit)	
			SAP	T P	SAP	T P	SAP	T P	SAP	T P
PUB	90.40%	0.00%	1.10%	1.10%	8.90%	8.90%	1.50%	1.50%	3.30%	3.30%
PVT	82.70%	0.00%	4.20%	4.20%	16.40%	16.40%	5.30%	5.30%	26.60 %	26.60%
ALL	88.10%	0.00%	2.10%	2.10%	11.10%	11.10%	2.70%	2.70%	10.30 %	10.30%

Note: - ES = CCR efficiency score obtained from grand frontier. RAP = Radial Adjustment Projection measured by (1-MS). SAP = Slack Adjustment Projection. T P = Total Projection. TP = RAP + SAP for inputs and TP = SAP for outputs

By the magnitude of amount of inputs reduction and output augmentation by the slack value adjustments, we can easily rank the input wise utilization efficiency and output wise production efficiency of the Indian banks. Input-IV being the lowest reduction required, ranks first, then Input-III, II and I. Output-I being lowest augmentation required ranks first followed by output III, output IV and output II as per the mean inputs reduction and output augmentation over the study period respectively. So, the Indian banks are more efficient in using 'deposit' and 'operating expenses' rather than 'branches' and 'employees' as inputs and more efficient in producing 'net interest income' and 'priority sector advance' rather the 'non-interest income' and 'net profit'. This suggests that most of the inefficient banks need to utilize properly their branches and employees and to enhance the level of non-interest income and profitability for projecting themselves onto the efficient frontier. It is also observed that public banks require lower amount of input-output improvement in all the years for each input and output than that of private banks in order to be efficient.

5.2.6.3: Reference Banks for Inefficient Banks

One of the important advantages of DEA methodology is to identify the reference banks or peer banks for each inefficient bank based on the positive lambda values of the efficient banks for an inefficient bank under consideration. Now we mention inefficient bank-wise reference banks or peer banks i.e. a set of efficient banks. Inefficient banks should follow their good operating practices to improve their efficiency.

Table: 5.13

Inefficient Bank wise Peer Banks

		Efficient banks with Lambda values											
		SN	1	2	3	4	5	6	7	8	9	10	11
Inefficient banks	SN	Banks	COB	IDL	OBC	UBI	SBT	CUB	FDB	KVB	HDB	ICB	KMB
	1	ALB		0.022	0.099	0.142	0.926	1.343					
	2	ANB								3.361	0.026	0.007	0.141
	3	BOB		0.029				4.074	2.923		0.253		
	4	BOI	0.781	0.268				6.735		1.447	0.149		
	5	BOM					0.290	3.960					0.228
	6	CAB	0.497	0.297			2.824	0.050					
	7	DEB						1.368		1.323		0.026	0.031
	8	PNB								13.369			1.182
	9	SYB	0.083				0.059	2.485		4.449			
	10	**UCB**					**1.454**	**1.206**					
	11	VJB			0.291		0.426	0.623					
	12	SBI		0.910				9.400		13.874	2.837		
	13	SBJ					0.136			1.853			0.492
	14	SBM		0.088						1.329			0.348
	15	BOR						1.070			0.030		
	16	DLB					0.017	0.249					0.054
	17	IVB								1.053		0.016	0.085
	18	LVB					0.043			0.303			0.014
	19	SIB	0.119		0.015		0.061	0.604					
	20	CBP										0.045	0.350

Note – based on grand frontier result (CCR model)

Peer banks for say UCB (UCO Bank) are SBT and CUB since their lambda values are positive corresponding the efficiency score of the bank UCB. To improve efficiency, UCB bank should follow SBT and CUB since their input output configuration of similar with UCB, an inefficient bank. Lambda values of SBT and CUB approximately 1.454

and 1.206 respectively show the proportion contributed to the point used to evaluate UCB.

That is projected inputs value of UCB =
(Input value of SBT) × *1.454* + *(Input value of CUB)* × *1.206*
Similarly projected output value =
(Output value of SBT) × *1.454* + *(Output value of CUB)* × *1.206*
UCB has more similarity to SBT than CUB from magnitude of lambda values. This explanation for reference set of other inefficient banks is similar.

5.3: Efficiency: Ownership and Size

There is no consensus about the factors that explain the underlying differences in efficiency. Two specific factors explaining efficiency differences are widely used in almost all previous studies in Indian context. Conclusion of their study is mixed. These are ownership and size. These two aspects have assumed added significance in view of the consolidation process that is underway in India.

In this section we are trying to examine the relationship between 'efficiency and ownership pattern' and 'efficiency and bank size'. These relationship analysis is simply based on the comparison of mean OTE scores and number of 100% efficient banks (CCR) grouped by ownership pattern and bank size.

5.3.1: Efficiency and Ownership

Public sector banks (PSBs) which are mainstay of the Indian banking industry and account for more than 70% of the commercial banking assets (as on 31.03.08) are severely facing competition with the emergence of private players. Listings of PSBs on stock exchanges and increased private shareholding have also enhanced the severity of competition. The new private banks which accounted for 2.6 per cent of the commercial banking sector in March 1997 have developed rapidly and accounted for nearly 17 per cent of the commercial banking assets by end March 2008. In this market condition a question comes to our mind- 'Are public banks pushed to the back side?'

In this background, it is very important to show the relationship between efficiency and ownership pattern i.e. whether ownership type plays as an important role for efficiency gain or not.

Banking literature provides mixed evidence regarding the effect of ownership on bank efficiency. In Indian context, most of the studies in the post-reforms period have recommended that there is no serious effect of the ownership on the efficiency variance. [e.g. Mohan and Ray[22] (2004); Mahesh et al.[23](2006)]. Even the most recent study by Reserve Bank of India[24] (2008) also concludes that in the Indian banking sector, ownership has no definite relationship with efficiency. Sathye[25] (2003) has shown that public banks are more efficient than private domestic banks. Bhattacharya et al.[26] (1997) has concluded that the public sector banks have been the most efficient followed by the foreign then the private banks. Some other studies in India have shown that banks' overall efficiency is found to be higher for public sector banks than for foreign and domestic private banks [e.g. Ataullah & Le[27] (2006); Sensarma[28] (2006); Shanmugan & Das[29] (2004)]. Ketkar et al.[30] (2008) has concluded that the foreign banks are found to be most efficient followed by the private and then the public banks during 1997-2004 under production approach. Debasish[31] (2006) supports the conclusion that foreign owned banks are on average most efficient and new banks are more efficient that old ones which are often burdened with old debts. Kumar and Gulati[32] (2009) agree that there is no significant relationship between ownership and efficiency.

In global context, a study by Berger et al.[33] (2004), using 28 developing nations from various regions finds foreign banks to have the highest profit efficiency, followed by private domestic banks, and then state-owned banks. Tahir and Haron[34] 2008 observed that domestic banks are more efficient compared to foreign banks in Malaysia during 2000-2006. Berger[35] et al. (2009) suggest that state owned banks (four big banks) are by far the least efficient; foreign banks are most efficient; and minority foreign ownership is associated with significantly improved efficiency in china during 1994-2003. Md. Usman[36] et al. (2010) found that foreign owned banks to be the most efficient followed by state owned banks and domestic private banks are found to be the least efficient in Pakistan during 2001-08. However, the results of Bonaccorsi di Patti et al.[37] (2005) for Pakistan show that efficiency gains are high for all banks during the early years of privatization but subsequently, the level of efficiency for privatized banks decreased. New private domestic banks are the shining example of better performance while foreign

banks lagged behind. So, literature provides mixed effect of ownership on efficiency level.

For this analysis first sample banks are categorized according to ownership type as follows

Box No: 5.1

Bank Groups by Ownership Pattern

Banks Group	Numbers of Banks
Nationalized Banks (NBs)	16
State Banks (SBs)	4
Old Private Banks (OPBs)	10
New Private Banks (NPBs)	6
Public Banks (PUBs)	20 (16+4)
Private Banks (PVBs)	16 (10+6)
All banks (ABs)	36

Note -Ownership groups as mentioned are based on the sample banks comprising major banks of each group. Therefore, selected banks in the sample represent their respective ownership groups

Table: 5.14

Mean Efficiency and F value of Banks Grouped by Ownership

Efficiency	Ownership	2005	2006	2007	2008	Grand Frontier
OTE	NB	0.902	0.919	0.929	0.932	0.926
	SB	0.967	0.973	0.931	0.912	0.958
	OPV	0.877	0.884	0.919	0.9	0.902
	NPB	0.985	0.96	0.998	0.975	0.991
	AB	0.916	0.922	0.938	0.928	0.934
	F-Value (sig)	1.91 (.147)	1.12 (.356)	1.44 (.249)	1.06 (.380)	1.54 (.223)
PTE	NB	0.928	0.95	0.948	0.955	0.949
	SB	0.994	1	0.976	0.948	0.993
	OPV	0.914	0.938	0.957	0.938	0.935
	NPB	1	0.974	1	0.988	0.995
	AB	0.943	0.956	0.963	0.955	0.975
	F-Value (sig)	1.58 (.212)	.76 (.522)	1.16 (.338)	.576 (.635)	1.294 (.29)
SE	NB	0.972	0.967	0.979	0.976	0.976
	SB	0.973	0.973	0.955	0.964	0.965
	OPB	0.962	0.94	0.961	0.961	0.966
	NPB	0.985	0.986	0.998	0.986	0.995
	AB	0.972	0.963	0.974	0.972	0.975
	F-Value (sig)	.192 (.901)	.91 (.447)	.776 (.516)	.394 (.758)	.450 (.718)

Note: Efficiency scores are based on overall technical efficiency. NB- nationalized banks group, SB- State Banks group, OPB- Old Private Banks, NPB - New private Banks and AB- All Banks (in the sample). All these groups are based on the sample banks. Mean scores are calculated on the basis of number of banks of the respective bank group.

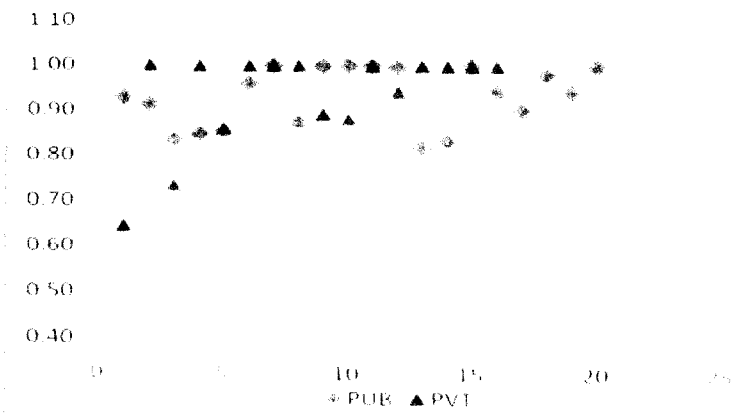
From the Table 5.14, it is observed that there is no significant difference in terms of mean score of all type of efficiency in all the years among the four ownership groups. Lower F value in one-way ANNOVA suggests the variation of efficiency due to difference among groups by ownership type is insignificant. This variation trend is decreasing over the study period. The larger the F-ratio, the greater is the difference between groups as compared to within group differences. F-value also suggests this efficiency variance by ownership is lowest in case SE. This would suggest that in the Indian context, the relationship between ownership and efficiency is not significant.

But Table 5.14 clearly shows that NPBs are the most efficient followed by the SBs, the NBs and the OPBs in terms of OTE based on the score (grand frontier) over the study period. In case of PTE, NPBs and SBs are equally efficient and then NBs and OPBs. In case of SE, this ranking is slightly changed - first NPBs followed by NBs then SBs and OPBs.

Insignificant relation between efficiency and ownership can also be justified by comparing the PUBs and PVBs in the top and least performing banks over the study period (see Table: 5.5). DEA efficiency and ownership analysis suggests that most efficient banks and least efficient banks are found both in the public and private sectors (Figure: 5.6).

Figure: 5.6

Efficiency and Ownership



Note: DEA efficiency (OTE) is based on grand frontier.

Inter groups (by ownership) efficiency comparison is different when it is based on number of 100% efficient banks.

Table: 5.15

Bank Group (ownership) wise Number of Fully Efficient Banks (in %)

Efficiency Type	Ownership Group	2005	2006	2007	2008	Grand Frontier
OTE /SE	NB	38%	31%	38%	25%	31%
	SB	50%	50%	25%	25%	25%
	OPV	30%	40%	50%	40%	50%
	NPB	67%	67%	83%	83%	83%
	AB	42%	42%	47%	39%	44%
	F-value	.74	0.76	1.55	2.41	1.94
PTE	NB	56%	50%	50%	56%	44%
	SB	75%	100%	50%	50%	75%
	OPV	50%	50%	60%	60%	60%
	NPB	100%	83%	100%	83%	83%
	AB	64%	61%	61%	61%	58%
	F-value	1.65	1.77	1.66	.50	1.18

Note: % is computed based on the number of banks of the respective bank groups.

First as per F value, there is no significant difference among the ownership groups in terms of number of 100% efficient during the study period as whole. But, F values clearly indicate this difference in terms of 100% efficiency of OTE is increasing over the study period and becomes significant in 2008 at 10% level of significance. Difference in terms of 100% efficiency of PTE is lower than that of OTE and it is more or less decreasing.

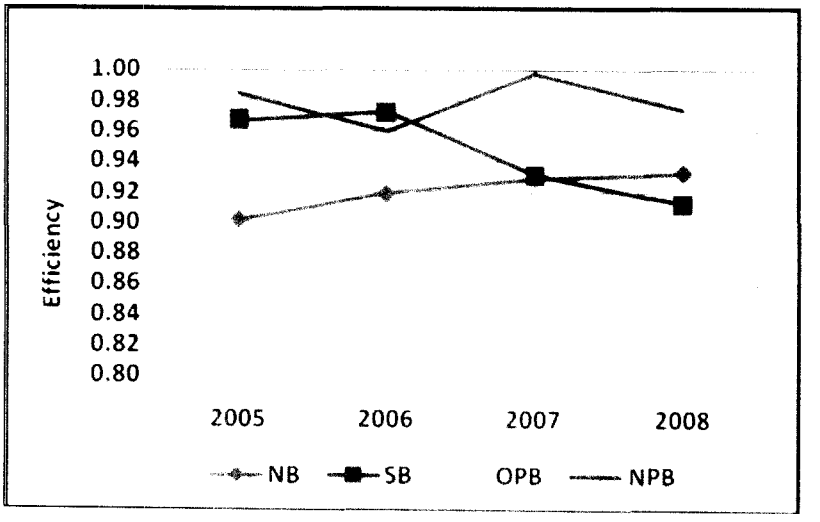
Table: 5.15 shows that NPBs group is the highest during all the years of the study and all other bank groups are inconsistent in their ranking position in terms of number of 100% efficient banks. However, about 83% of NPBs are CCR and BCC efficient banks based on grand frontier results. Interestingly OPBs which are least efficient in terms of mean score is the second highest in terms of number of 100% efficient banks. 75% of SBs are fully efficient in PTE which turns out them to second position among the four ownership groups in PTE. NBs are third in terms of OTE but the least in PTE. So the variance among the ownership in terms of fully efficient banks is higher than that of in terms of mean score. This variation is also present when it is compared between PUBs and PVBs also.

So with this efficiency analysis by ownership based on mean efficiency score suggests that ownership type has no definite relationship with efficiency. But it is to be noted that private banks are ahead of public banks when it is compared in terms of number of fully efficient banks.

'Efficiency and ownership' relationship analysis also helps to the various insights of efficiency among these four ownership groups.

Figure: 5.7

Average Efficiency (OTE) of Banks grouped by Ownership



Above Figure: 5.7 show the trend of efficiency (OTE) of the four ownership groups. Efficiency score of the entire bank groups except NBs are fluctuating over the study period. NBs only have been experiencing a steady increasing trend in OTE during the study time even in 2007-08 when efficiency score of all other groups decline. This steady growth of NBs is mainly because of achieving higher efficiency gain in scale efficiency caused by interconnection among the branches through core banking solution system (CBS) after 2005.

NPBs are most efficient in all the years except in 2005-06 because of two banks CBP (.840) which is suffering tremendously from inefficient management and IIB for profitability problem. Inefficient management and also scale inefficiency of CBP was also again responsible for highest fall of 2.32% in OTE of NPBs in 2007-08 in comparison to 2006-07.

Scale inefficiency of SB (16.8% in 2007, 13.6% in 2008) and managerial inefficiency of SBM (14.3% in 2008) are held responsible for slightly decreasing trend of efficiency of SBs after 2006. It is pointed out that scale efficiency of SBs group excluding SBI is on an average .986 which is the second highest among the groups.

OPBs are least efficient mainly because of worst performance of four banks – BOR and DLB, IVB and SIB.

Managerial inefficiency is the main source of overall technical inefficiency for NBs and OPBs where it is scale inefficiency in case of SBs. So the earlier observation of technical inefficiency largely due to pure technical inefficiency is mainly because of the banks belonging to OPBs and then NBs.

5.3.2: Efficiency and Bank Size

For the last two decades, the pace of financial market liberalization has increased in developing countries like India and creates greater competitive pressure which will affect local banks. In order to survive, banks are now going for merger and acquisitions scheme that is underway all over the world. One of the reasons for the consolidation process is the desire to achieve economies of scale. Moreover, mergers and acquisitions in the banking industry have resulted in large universal banks in terms of total assets, products, and geographical diversification. Large banks are in a better position to introduce technology and reduce cost than small banks. Large banks have normally large capital and easily utilize economies of scope. For all these reasons, size of banks is considered to be normally associated with higher efficiency. Bank size thus is now an important factor in today's banking efficiency analysis study. Information on optimal bank size is important, as this will enable policy-makers to formulate appropriate and sound policies to direct their banking industry. The optimal size of a bank depends on several factors like level of economic development, the number and diversity of financial institutions/instruments, the competitive situation in the market etc.

However banking literature does not suggest a consistent relationship between size and efficiency. In the Indian context, Ray and Sanyal[38] (1994) observed large economies of scale in the cost structure of banks, which decreases with increasing size.

Chartterjee[39] (1997), using bank deposits as outputs, indicated that small banks also feature inherent economies of scale. Moreover, Das[40] (2003), utilizing regression analysis, found a negative correlation between bank size and efficiency estimates in India. Large size banks are more efficient than small size banks as per the recent study RBI[41] (2008). Debasish[42] (2006) finds the smaller banks are globally efficient, but large banks are locally efficient. Kumar and Gulati[43] (2009) in their recent study has shown that there is a significant difference between large and medium banks with regard to Scale Efficiency (SE).

In global context, economics of scale of commercial banking operating in the US have been extensively studied (e.g. Humphrey 1990[44]; Berger and Humphrey[45] 1991; Noulas[46] 1990). They suggest economies of scale exist only for small banks. Analysis of cost structure of European banks (e.g. Zardkoohi[47] (1994) for Finland; Lang and Welzel[48] (1994) for Germany) indicate the presence of scale economics only for financial institutions of small and medium size. Rezvanian[49] et al. (2002) also finds that there are economics of scale for small and medium size banks in Singapore during 1991-1997. In a study by Asror NIGMONOV[50] (2010) the investigation of differences between the small, medium and large banks lead to the observation of significant difference between the small and medium sized banks in Uzbekistan during 2004-06. However, some studies have found significant positive relation between size and efficiency [Halkos and Salamouris[51], 2004; Drake et al.[52] (2003) Rangan et al.[53] (1988); Miller and Noulas[54] (1996)] some other negative relation (Hermelin and Wallace[55], 1994; Ali et al.[56] (1993)) and some others find insignificant relation (Mester[57], 1993; Girardone et al.[58], 2004; Isik and Hassan[59], 2002).

For analysis of relationship between efficiency and size, sample banks are classified into three groups – large, medium and small, based on the value of total assets.[60] Out of 36 sample banks, first 12 banks with highest value of total assets are considered as large sized banks next 12 banks as medium sized and the remaining 12 banks with lowest assets value as small sized banks. Large size banks contribute on an average 74% of the total assets of the sample banks while medium and small size banks contribute 20% and 6% respectively.

Table: 5.16

Mean Efficiency of the Banks grouped by Size

		2005	2006	2007	2008	Grand Frontier
Mean Score						
OTE	Large	0.915	0.928	0.924	0.947	0.934
	Medium	0.928	0.957	0.959	0.933	**0.954**
	Small	0.905	0.881	0.931	0.904	0.913
	Total	0.916	0.922	0.938	0.928	0.934
PTE	Large	0.954	0.956	0.958	0.981	0.963
	Medium	0.941	0.976	0.966	0.941	0.966
	Small	0.935	0.937	0.964	0.942	0.944
	Total	0.943	0.956	0.963	0.955	0.958
SE	Large	0.959	0.969	0.964	0.965	0.970
	Medium	0.986	0.980	0.993	0.991	**0.987**
	Small	0.969	0.940	0.966	0.960	0.969
	Total	0.972	0.963	0.974	0.972	0.975
Number of 100% Efficient Banks						
OTE &SE	Large	5	5	5	4	5
	Medium	5	6	6	5	5
	Small	5	4	6	5	6
	Total	**15**	**15**	**17**	**14**	**16**
PTE	Large	8	8	8	10	**8**
	Medium	8	7	6	5	6
	Small	7	7	8	7	**7**
	Total	**23**	**22**	**22**	**22**	**21**

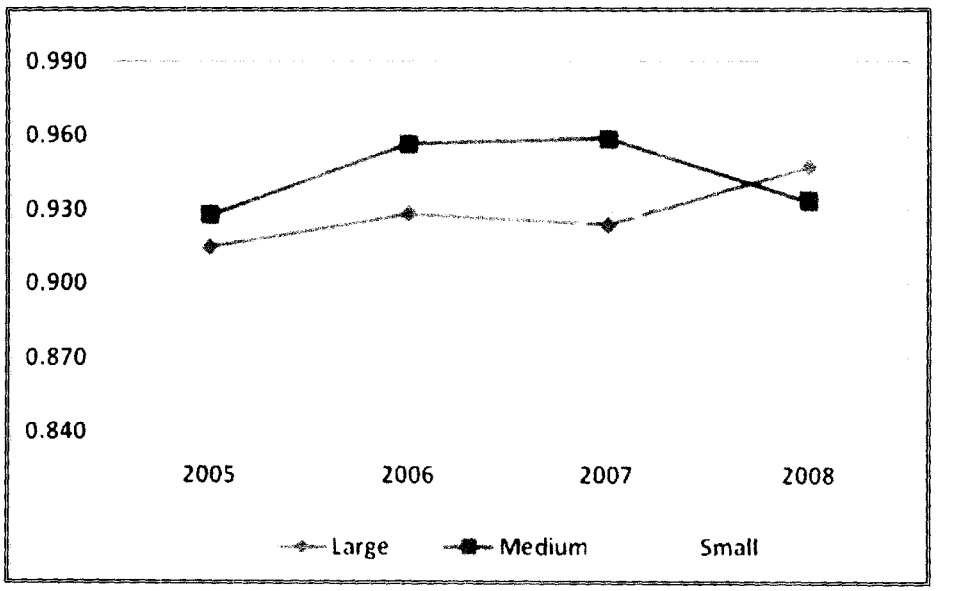
First it is clear from the Table: 5.16 that there is no significant difference between the three groups of banks by size in terms of mean efficiency score and number of 100% efficiency banks during all the years under study. Given these empirical results, the issue of the relationship between size and efficiency remains unresolved.

However, mean score of the OTE of the medium sized banks are highest in all the years except in 2008 when large size banks are the top most while small banks are the least in all the years except in 2007. So far as PTE is concerned large banks are highest in 2005 and 2008 and medium banks in 2006 and while medium and small size banks are almost equally efficient in 2007. In case of SE, medium size of banks are the most efficient in all the years while large and small banks are all most equal with a slight variation from year to year.

On the whole, an analysis of efficiency by size reveals that the medium sized banks appear to be the most efficient in terms of OTE (more than 2% of large size and 4% of small size) and SE (more than 3% of both large and small size) over the entire study period (based on GF). Large size and medium size banks are the most managerial efficient (PTE). Small size banks are least efficient in all the score.

Figure: 5.8

Average Efficiency (OTE) of Banks grouped by Size



Large size banks are in a more favorable position as indicated by the slow but steady positive efficiency growth of OTE in spite of the fact that three least performing banks- UCB, SYB and BOB (see, Table: 5.5) are within this group. In this growth journey, large size banks reach to the highest score in 2008. The reason for steady growth of large size banks may possibly be the improvement of management efficiency (PTE), well capitalization, strong internal and risk management system, technology use, vast customer base, proper accounting and disclosure and so forth of four top performing banks- IDL, ICB, HDB and UBI both in OTE & PTE and two banks - SBI and PNB in PTE. In all, medium and large sized banks are more efficient than the small sized banks. This suggests that larger banks in India tend to achieve higher efficiency gain. This observation of steady growth of efficiency score of large sized banks and higher efficiency gain by larger banks during study period validates the recent trend of merger and acquisition which is underway in the Indian banking sector.

Decomposing technical efficiency to its components – pure technical efficiency and scale efficiency – taking size into consideration, reveals that medium and small sized banks' inefficiency is mainly due to pure technical inefficiency i.e. PTIE> SE, whereas these are almost equal in case of large sized banks. This finding modifies again the earlier findings that the pure technical inefficiency contributing more than scale inefficiency towards overall technical inefficiency is mainly because of smaller size banks and most of them are in the nationalized and old private ownership group. This finding also reflects that efficiency gain could be achieved if small and medium size banks improve management efficiency and large size banks adjust their size of operation.

5.4: Ranking of Indian Banks

In this section, we are trying to develop a humble approach for ranking of the Indian banks. Ranking is a well established approach in social science and thus it is a pertinent issue in the banking efficiency study. In DEA context, ranking of organizational units has become also a well established approach in the last decade. There are several ranking methods in DEA literature (Adler et al.[61], Sexton[62] (1986) was the first to introduce full rank scaling of organizational units in DEA context by utilizing the Cross-Efficiency Matrix. Super-efficiency approach developed by Andersen and Petersen[63] (1993) is the most widespread ranking method in DEA literature.

In this study, input-oriented super-efficiency model under constant return to scale assumption as proposed by Andersen and Petersen (1993) is followed for ranking the banks under study. (Super-efficiency model is discussed in Methodology section). Besides, ranking by super-efficiency scores, the study has made overall rankings or composite rankings of the banks based on three parameters namely super-efficiency, profit efficiency and risk efficiency.

5.4.1: Rankings: Super-efficiency

Basic DEA models cannot provide rankings to the efficient banks as because of efficiency scores of all efficient DMUs are equal to 1 (one). Super-efficiency model solves this problem by allowing efficiency score of efficient banks as indentified by the basic models greater than or at least equal to the value of 1(one). Efficiency scores of

inefficient banks remain unchanged. The super-efficiency model is almost identical to the basic DEA models with the exception that the efficient DMUs being evaluated are allowing efficiency score greater than or at least equal to the value of 1(one). An important consideration of this model is that efficiency scores of inefficient DMUs remain unchanged. Table 5.17 clearly shows that efficiency scores of fully efficient banks indentified by CCR model exceed or at least equal to efficiency score of 1 (one) where as they are remain unchanged for inefficient ones.

Table: 5.17

Year wise Super-efficiency Scores and Ranking of Banks

	2005		2006		2007		2008		Grand Frontier	
Banks	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
ALB	0.848	27	0.901	25	1.019	14	1.022	14	0.93	23
ANB	1.056	11	0.879	26	0.887	28	0.892	25	0.913	24
BOB	0.878	26	0.817	31	0.827	32	0.809	34	0.838	32
BOI	0.762	33	0.78	34	0.814	34	0.95	19	0.85	31
BOM	0.746	34	0.873	27	0.852	29	0.904	24	0.858	30
CAB	0.897	23	1.014	13	0.984	19	0.937	20	0.962	19
COB	1.081	9	1.009	14	1.011	15	1.041	12	**1.045**	12
DEB	0.772	32	0.904	24	0.936	23	0.832	32	0.874	28
IDL	1.413	3	1.888	2	1.545	2	1.684	2	1.555	3
IOB	0.975	19	0.99	16	1.02	13	0.983	16	1.006	16
OBC	1.185	6	1.083	10	1.008	16	1.026	13	1.067	11
PNB	0.928	21	0.963	18	0.961	20	0.963	17	0.999	17
SYB	0.848	28	0.863	28	0.825	33	0.862	28	0.822	34
UCB	0.775	31	0.796	32	0.84	30	0.826	33	0.838	33
UBI	1.132	8	1.056	11	1.098	7	0.998	15	1.132	6
VJB	1.033	14	0.939	20	0.94	22	0.962	18	0.944	21
SBI	0.891	25	0.931	21	0.832	31	0.865	27	0.903	25
SBJ	1.046	12	1.014	12	0.96	21	0.933	21	0.983	18
SBM	0.977	18	0.959	19	0.932	24	0.852	29	0.946	20
SBT	1.04	13	1.004	15	1.096	8	1.176	5	1.125	7
BOR	0.632	36	0.562	36	0.746	35	0.651	36	0.646	36
CUB	1.062	10	1.176	5	1.023	12	1.048	11	1.068	10
DLB	0.702	35	0.736	35	0.733	36	0.783	35	0.735	35
FDB	0.894	24	0.986	17	1.048	11	1.125	8	1.017	15
IVB	0.818	29	0.912	23	0.904	26	0.839	31	0.86	29
JKB	0.981	17	1.091	9	1.127	5	1.116	10	1.136	5
KTB	1.135	7	1.113	6	1.008	17	0.914	23	1.026	13
KVB	1.021	15	1.109	7	1.12	6	1.134	7	1.087	8
LVB	0.94	20	0.793	33	0.909	25	0.878	26	0.894	26
SIB	0.799	30	0.851	29	0.896	27	0.932	22	0.883	27
AXB	0.92	22	1.093	8	1.076	9	1.151	6	1.085	9
CBP	0.988	16	0.84	30	1.059	10	0.849	30	0.943	22
HDB	1.303	4	1.322	4	1.331	4	1.191	4	1.267	4
ICB	1.907	1	2.274	1	3.277	1	2.192	1	2.238	1
IIB	1.247	5	0.919	22	0.988	18	1.124	9	1.022	14
KMB	1.606	2	1.487	3	1.365	3	1.657	3	1.561	2

Note-- Grant Frontier score i.e. efficiency score using average inputs and outputs over the study period (2005-08).

Table: 5.17 depict the rankings of the sample banks based on super-efficiency model. Efficiency score of efficient bank like COB 1.045 (based on grand frontier scores) indicates that COB can maintain it's fully (100%) efficiency status even after maximum proportional increase in inputs presently used by about 4.5%. Efficiency score of inefficient DMU like 'UCB' remains unchanged. Thus, input oriented SEM provides a means of evaluating the extent to which an efficient DMU is able to increase its input level without losing its status as a 100% efficient DMU. Super-efficiency score therefore provides a measure of stability of the 'efficient' status of the efficient DMUs.

Table: 5.18

Rank wise Super-efficient Banks over the study period

Rank	Banks	Rank	Banks	Rank	Banks	Rank	Banks
1	ICB	10	CUB	19	CAB	28	DEB
2	KMB	11	OBC	20	SBM	29	IVB
3	IDL	12	COB	21	VJB	30	BOM
4	HDB	13	KTB	22	CBP	31	BOI
5	JKB	14	IIB	23	ALB	32	BOB
6	UBI	15	FDB	24	ANB	33	UCB
7	SBT	16	IOB	25	SBI	34	SYB
8	KVB	17	PNB	26	LVB	35	DLB
9	AXB	18	SBJ	27	SIB	36	BOR

Note: Based on grand frontier super-efficiency

The Table 5.18 also classifies the banks into extreme and not extreme groups for over the study period. The first four super efficient banks in all the years ICB, IDL, KMB and HDB. ICB is the most super efficient banks in all years under study.

5.4.1.1: Projection of Efficient banks

Super-efficiency model provides the inputs outputs projection for both efficient and inefficient banks for improving efficiency. Projections for inefficient banks are same as basic model CCR (Presented in Table 5.11). Projection for efficient banks as per input oriented super efficiency model indicates how much inputs to be increased so that they can maintain 100% efficiency position. Table 5.19 provides input-output projection of the efficient banks as per grand frontier results. Each efficient bank can maintain its 100%

strongly efficient status even after changes in the inputs and outputs by the percentage mentioned for each bank in Table 5.19.

Table: 5.19

Input-output Projection for Efficient Banks

		Change(%) in Inputs				Change(%) in Outputs			
DMU	Score	No of Branches	No of Employees	Operating Expenses	Deposit	Net Interest Income	Non-Interest Income	Priority Sector Advance	Net Profit
ICB	2.238	123.8%	72.8%	3.9%	4.4%	0.0%	0.0%	14.5%	13.7%
KMB	1.561	56.2%	-10.3%	-18.3%	56.2%	0.0%	17.7%	0.0%	19.0%
IDL	1.555	-40.3%	-6.7%	55.5%	-2.5%	136.8%	0.0%	4.1%	0.0%
HDB	1.267	26.7%	21.2%	26.7%	26.7%	0.0%	28.1%	57.7%	38.1%
JKB	1.136	13.6%	-1.0%	13.6%	-16.1%	0.0%	47.6%	51.4%	45.0%
UBI	1.132	13.2%	9.0%	13.2%	-0.9%	8.9%	41.8%	9.8%	0.0%
SBT	1.125	12.5%	-10.8%	12.5%	12.5%	2.2%	59.0%	0.0%	15.8%
KVB	1.087	0.8%	8.7%	8.7%	8.7%	0.0%	0.0%	2.5%	0.0%
AXB	1.085	0.5%	8.5%	8.5%	-14.2%	0.0%	10.2%	0.0%	16.1%
CUB	1.068	-19.1%	-11.1%	6.8%	6.8%	0.0%	0.0%	0.0%	5.1%
OBC	1.067	-8.4%	6.7%	6.7%	-13.1%	0.0%	35.7%	0.0%	0.0%
COB	1.045	4.6%	4.0%	4.6%	4.6%	0.0%	0.0%	0.0%	0.0%
KTB	1.026	-6.7%	2.2%	2.6%	-6.7%	0.0%	0.0%	13.6%	4.4%
IIB	1.022	-19.1%	2.2%	2.2%	-16.0%	0.0%	45.1%	0.0%	0.0%
FDB	1.017	-7.7%	1.7%	1.7%	1.7%	0.0%	0.0%	0.0%	12.0%
IOB	1.006	0.6%	-4.9%	0.6%	0.6%	0.0%	27.3%	0.0%	0.0%

Note: As per grand frontier results of super efficiency model.

In a input-oriented DEA model, an input projection less than maximum proportional increase over 100% (e.g. in case of ICB 223.8% -100% =123.8%) allowed by the production possibility set, indicates the presence of non-zero slack in case of inputs and outputs which are to be increased, indicate the presence of non-zero slacks. In case of ICB, out of four inputs, three inputs except 'Number of Branches' and two outputs 'Priority Sector advance' and 'Net Profit' has non-zero slacks and thus, they have no impact on its super-efficiency score. Same explanation is for other banks.

This projection also indentifies input wise efficiency level of the individual banks (as per row wise % of changes in inputs of the respective banks of Table: 5.19). Higher the % of increase in inputs better is the utilization level of inputs. Thus the order of efficient use of four inputs in case of ICB is first No. of Branch (123.75%) followed by

No. of Employees (72.38%), Deposit (4.4%) and then operating expenses (3.9%). In case of outputs having zero slacks indicate better production.

Table 5.19 also identifies input wise efficient level of utilization among all the sample banks (as per column wise % changes in inputs of Table: 5.19). ICB is the most efficient in use of two inputs – 'No of Branches' and 'No of employees' while IDL for 'Operating Expenses' and KMB for 'Deposit' out of the sample banks. COB and HDB are the banks which is almost equally efficient in use of four selected inputs indicating almost same percentage of increase in all the inputs.

5.4.1.2 Reference Sets for Efficient Banks

DEA efficiency model of Andersen and Petersen also provides reference sets or peer banks for both efficient and inefficient banks. Reference sets for inefficient banks are same as basic CCR model presented in Table 5.13. Reference sets for efficient banks are presented in the following Table 5.20.

Table: 5.20

Efficient Bank Wise Reference Sets

DMU	Score	Rank	Reference set (lambda)				
ICB	2.24	1	IDL (3.44)	KMB (6.04)			
KMB	1.56	2	SBT(.110)	HDB(.12)	ICB (.02)		
IDL	1.56	3	KTB (.08)	ICB (.02)			
HDB	1.27	4	JKB (.03)	AXB (.99)	KMB (2.93)		
JKB	1.14	5	UBI (.22)	HDB (.04)			
UBI	1.13	6	CUB (6.15)	KVB (5.9)			
SBT	1.13	7	IDL (.16)	KVB (2.86)	KMB (.06)		
KVB	1.09	8	IDL(.02)	UBI (.08)	CUB (.12)	KMB (.02)	
AXB	1.09	9	OBC (.21)	HDB (.11)	ICB (.15)		
CUB	1.07	10	UBI (.03)	FDB (.06)	KVB (.07)		
OBC	1.07	11	COB (.89)	IDL (.1)	UBI (.07)	SBT(.24)	
COB	1.05	12	IDL (.11)	OBC (.11)	UBI (.17)	FDB (.63)	HDB (.06)
KTB	1.03	13	IDL (.06)	CUB (2.33)			
IIB	1.02	14	IDL (.08)	OBC(.04)	UBI (.01)	ICB (.04)	
FDB	1.02	15	COB (.39)	CUB (.68)	JKB (.07)	HDB(.003)	
IOB	1.01	16	SBT (.47)	CUB (7.19)	JKB (.27)	HDB (.16)	

Note: As per grand frontier results of super efficiency model.

Reference banks for ICB are IDL and KMB since their lambda values are positive under evaluation of ICB. Lambda values of IDL and KMB approximately 3.44 and 6.04 respectively show the proportion contributed to the point used to evaluate ICB. That is, projected inputs value of ICB =

(Inputs value of IDL) × *3.44* + *(Inputs value of KMB)* × *6.04.*

ICB has more similarity to KMB than IDL from magnitude of lambda values. ICB should follow the operating practices of KMB and IDL particularly for improving the use of two inputs- 'Deposit' and 'Operating Expenses' respectively. This explanation for reference set of other efficient banks is similar. From the Table 5.20 it is also found out that the IDL has the highest frequency (7 times) in the reference set than HDB and UBI both having 6 times. ICB which is the most super-efficient is referred for 4 times only for other efficient banks. Higher frequency in reference set in DEA indicates higher efficiency strength.

5.4.2: Rankings: Technical Efficiency and Financial Efficiency

The study has selected inputs and outputs specification after extensive verification of various input output combinations taking into consideration the major banking literature. But it is to be remembered that DEA results are very sensitive to the selection of input output variables[64] Number of inputs outputs, sample size, inclusion/exclusion of variables even model specification can affect the results. Another caveat of DEA is that those DMUs indicated as efficient are only efficient in relation to others DMUs selected in the sample. They may be inefficient outside the sample. In this study it may seem that ICB is the most super-efficient because of selecting 'No. of Branches' as one of the input variables. (ICB is the most efficient in using this input relative to other banks in the sample as per super-efficiency model). KMB which is the most efficient in using the input of 'Deposit' may be inefficient if it is considered as output under production approach. Therefore, ranking based only on Andersen and Petersens' ranking method i.e. super-efficiency scores should not be valid and justifiable. Cooper and Tone[65] rightly criticized Andersen and Petersens' ranking method. They do not rank efficient units as they claim that they all are on the efficient frontier. Moreover they do not accept DEA score as a ranking score for inefficient units since their weights vary from unit to unit.

Therefore it is necessary to rely on other efficiency parameters in addition to DEA efficiency to make ranking of the banks more reliable and justifiable. The study considers two financial parameters, profit efficiency and risk efficiency, in addition to DEA super efficiency for overall rankings of the sample banks for each year and for the study period as a whole.

Thus for overall rankings, we have considered three parameters to capture three important efficiency aspects – technical efficiency, profitability and risk which are essential for existence and sustainable growth of the banks in today's banking scenario. For measurement of profitability and riskiness, we basically rely on most frequently used financial ratios with some modifications. A common approach to efficiency and productivity analysis in the banking sector is ratio analysis, whereby a banking unit is judged in terms of certain ratios computed mainly from the financial statement. But ratio analysis is not a viable technique for drawing any economic conclusion because of differences in accounting practices and norms in different economic environments[66]. Inspite of this limitation, these ratios are still highly popular in financial analysis. Chandra[67] (2004) suggests that it works well if one is aware of accounting bases and makes adjustment for them. The popularity of ratios also emanates from the fact that most of the supervisory systems across the globe rely on these ratios such as CAMELS rating. So, overall rankings, we consider DEA efficiency as well as financial efficiency consisting of profit and risk efficiency.

Accordingly, DEA efficiency has been selected as the first criterion for overall rakings of the Indian banks with highest weight of 50% as because DEA technique is superior to ratio technique for efficiency evaluation. . Two other criteria – profitability and riskiness are assigned with equal weights of 25% each considering that they are equally important in current banking scenario. However, the study has developed four step procedures as under for overall rankings –

Step-1: Ranking banks based on each of the three parameters separately.

Step-2: Multiplying ranks by the weights assigned to the respective parameters.

Step-3: Aggregating weighted ranks resulting into composite index that determines overall rankings.

Step-4: Overall ranking is assigned by giving the best rank with least composite index i.e. lower composite index indicates better performance.

Above mentioned procedures are followed for year wise overall rankings as well as study period overall rankings of the sample banks.

5.4.2.1: Profit and Risk Efficiency Measurement

It is widely perceived that the competition among the banks operating in India has increased since the inception of financial sector reform in 1992. The competition level is increasing day by day. Banks are now in the race of becoming the best in the country by offering a host of products and services for better customer satisfaction. Indian banking is now in a position of "the survival of the fittest". In order to survive banks must be profitable. Profitability is therefore an important issue in this customer oriented market economy. In the race of making more profit, banks are forced to take risk in various respects. Thus, risk management is also an important and recent consideration of bank performance.

We have chosen two micro indicators and five micro indicators to measure and represent profit efficiency and risk efficiency respectively.

Composite scores of the selected ratios of each efficiency parameter (Box No: 5.2) measure the respective efficiency.

Box No.: 5.2

Indicators and Measuring Variables of Profitability and Riskiness

Profitability Indicators	*Measuring Variables*	*Indication of profitability*
1.Return to Assets (ROA)	Net Profit/ Average Total Assets	Higher ratio indicates better profitability
2.Return on Equity (ROE)	Net Profit/ Equity	Higher ratio indicates better profitability
Risk Indicators	***Measuring variables***	***Indication of riskiness***
1.Capital Adequacy (CAR)	Capital / Risk-weighted Assets	Higher ratio indicates lower risk
2.Asset Quality (AQY)	Net NPA / Net Advance	Lower ratio indicates lower risk
3.Management Quality (MQY)	Operating Expenses / Operating Income	Lower ratio indicates lower risk
4.Liquidity (LDY)	Liquid Asset / Total Assets	Higher ratio indicates lower risk
5.Riskiness (RI)	Risk Index (RI*) = [E(ROA) + CAP] / SD_{ROA}	Higher ratio indicates lower risk i.e. safer

Note: Risk indicators or parameters are chosen mainly from the point of view of CAMEL analysis Technique. (CAMEL stands for Capital Adequacy, Asset Quality, Management Quality, Earning Quality and Liquidity) and risk index proposed by Hannan and Hanweck (1988). Earning quality as per CAMEL rating is considered as the profit efficiency separately. All the ratios except RI are taken from the Statistical Table Relating to Banks, RBI (various years).*

Following two steps method are developed for computing composite score in a very meaningful and easy to understand way.

Step I- Converting each ratio of absolute measure to relative measure pattern following either output-oriented or input-oriented DEA concept of efficiency.

[Output-oriented technique is followed for the ratios indicating higher the ratio better the performance. And input oriented technique is used for the ratios indicating lower the ratio better the performance.

Output-oriented DEA efficiency =Actual performance / Best possible Performance.

Input-oriented DEA efficiency = Best possible Performance /Actual performance

Where Actual Performance (AP) is nothing but the actual ratio value of a bank and best possible performance (BPP) is considered as average ratio values of four best performing banks (one each from four ownership banking groups) in that ratio. Best performing bank is nothing but a bank having highest (or lowest in case of ratio indicating lower the ratio better the performance) value in the respective ratio. The bank whose actual performance equal to or more than (or less than in case ratio indicating lower the ratio better the performance) the best possible performance is assigned efficiency score equal to or more than one which is similar with Andersen and Petersens' super-efficiency score. The justification for calculating best possible performance (BPP) in this manner is to capture the differences among the banking groups in various respects – objectives, ownership pattern, Government's agent, age of operation, area of operation, use of technology, political influence, professional attitude, and labor union and so on.

Step II –Averaging relative values of each ratio of each bank results its composite score. This composite score indicates profitability and riskiness of the banks.

Profitability and riskiness measured as such are named in this efficiency study as profit efficiency (PE) and risk efficiency (RE) in tune with technical efficiency of DEA methodology. These two efficiencies may be jointly named as financial efficiency (FE).

Now we discuss briefly the micro parameters selected for profit and risk efficiency measurement.

ROA and ROE

ROA and ROE are both commonly and widely used variables to measure the profit performance of banking. ROA shows the profit earned per rupee of assets. ROA reflects the ability of the firm to generate profit on its resources. It depends on bank's policy as well as economic and government regulation policy. ROE, on the other hand, reflects how efficiently a bank's management is using its shareholders' funds. ROE depends on ROA as well as degree of financial leverage.

Many regulators believe that ROA is the best measure of bank profitability. Rosly and Abu Bakar[68] 2003 points out that ROA are the best measure of banking profitability to most analysts. Riverd and Thomas[69] suggest that bank profitability is best measured by

ROA as ROA is not distorted by high equity multiplier. However, most of the studies use ROA to measure bank profitability and therefore financial leverage i.e. fund management efficiency to increase return of owners is ignored in their study. Besides, ROA may be biased due to income from off-balance sheet activities as it is not reflected in the balance sheet. Higher ROA does not necessarily mean higher return to owners. But ultimate objective of the banks in a very competitive market is to earn a strong return for its owners with a reasonable risk to improve market holdings.

Since return on assets tends to be lower, most banks utilize financial leverage heavily to augment return on equity in a competitive level (Hassan and Basir[70] 2003). ROE considers financial leverage but disregards risk associated with leverage high return on equity indicate higher profitability but there may be high financial risk and therefore should not be good measure of bank profitability. So in my study, profit efficiency is estimated by combining ROA and ROE in order to capture both operating efficiency as well as fund management efficiency.

Capital Adequacy Ratio (CAR)

It measures the amount of banks capital in relation to risk weighted assets. It determines the capacity of banks to withstand the unexpected losses arising out of operations. Higher the capital adequacy ratio a bank has, greater the ability it has to absorb unexpected losses before becoming insolvent. Thus CAR which took into account the element of risk involved in both balance sheet as well as off-balance sheet business, emerged as a well recognized and universally accepted measure of riskiness and soundness of the banking system. CARs of all the banks groups in India have improved significantly over the study period. All the sample banks have reached double digit CAR, a commendable achievement except DLB (9.21%) which is just above the minimum requirement of CAR (9%), one percentage point above the Basal II norms.

Asset Quality

The efficiency of a bank is seriously affected if its asset quality is poor. Non-performing assets requires provisioning which results higher cost, lower profit (increasing losses) leading capital erosion. We select net NPA to net advance ratio as

measure of credit risk. The higher this ratio the larger the credit risk is. In India, non-performing assets of the commercial banks gradually declined over the years. [Net NPA was 8.1% (1996-97) it is now just 1% (2007-08)]. Income recognition, asset classification and provision norms are the major contributors of the improvement of the asset quality of the banks in the post reform period. Besides the various steps such balance sheet clearing through compromise settlement of chronic NPAs, corporate debt restructuring, setting up of debt recovery tribunals and introduction of SARFAESI act, macro economic development over the years and improvement in bank management quality are also responsible for declining the NPA level of the Indian banks. It is also noticeable that performance comparison based on particular NPA ratio cannot produce justified conclusion. SBI of 150 years and KMB of 5 years journey in banking operation with different perspective of commitment and obligation towards the society and with different political influence are obviously different in terms of NPA performance. In spite of that, after 15 years of post reform era, when all the banks are capable to reduce their NPA level (most significant improvement has been observed in respect of nationalized banks) NPA ratio may be considered for performance evaluation. We select Net NPA to net advance ratio for measuring credit risk efficiency to assess the management quality mainly i.e., from bad management point of view.

Operational Efficiency Ratio

This ratio is now a days a greater consideration by the researchers to evaluate operational performance of the banking. The higher the ratio the greater the operational risk is. In a computerized banking arena, this ratio is coming down year by year across all the bank groups to prove tight management of institution and profit planning.

Liquidity Ratio

We select 'Cash and Balances with RBI to Total Asset Ratio' to measure risk from the liquidity aspect. The higher this ratio, the stronger is a position to absorb liquidity shocks. Major studies selects credit deposit ratio for measuring liquidity risk. Credit deposit ratio as measure of liquidity (the lower the ratio, the higher is liquidity efficiency) disregards its ability to measure the soundness of the banking (the higher the

ratio the better is the soundness of the bank). The study would like give more weightage to this ratio as a measure of soundness of banking in this very competitive market and selects cash and balances with RBI to total asset as a liquidity measuring variable.

Risk Index (RI)

Risk index suggested by Hannan and Hanweck[71] (1998), is a measure of riskiness of banks. Risk Index = [E (ROA) + Capital] / SD_{ROA}

Where E *(ROA) expected returns on Assets*

Capital is the inverse of Equity multiplier i.e. Net Worth / Total assets

SD_{ROA} is the Standard Deviation of ROA

RI, expressed in units of standard deviations of ROA, is a measure of how much a bank's accounting earnings can decline until it has a negative book value. The RI equation is an appealing risk measure because it includes ROA: the most widely accepted accounting measure of overall bank performance, the variability of ROA which is a standard measure of risk in financial economics, and book capital adequacy which represents an industry standard for bank safety and soundness. These three parameters of RI are widely used consideration of the recent banking evaluation. Therefore this RI should be an important consideration in the field of efficiency evaluation. RI scores indicate the level of risk efficiency. A lower risk index score implies a riskier bank while a higher implies a safer bank. RI is calculated taking last four years data including the year of calculation.

Year wise profit efficiency and risk efficiency score of the individual banks are given in Annexure: 5. (E). Table 5.21 and Table 5.22 provide the descriptive statistics of profit efficiency and risk efficiency respectively.

Table: 5.21

Descriptive Statistics of Profit Efficiency				
	Mean	Std. Deviation	Minimum	Maximum
2005	0.571	0.361	-0.584	1.087
2006	0.613	0.286	0.038	1.044
2007	0.682	0.203	0.225	1.068
2008	0.727	0.215	0.261	1.073
Grand Frontier	0.648	0.218	0.187	1.026

Mean scores suggest that profitability of the Indian banks is steadily increasing over the years under study with an average of 64.8%. SD of the profit efficiency is also decreasing and indicates that all the banks are in the profit making approach. No one bank in the sample makes loss after 2005. So, deregulation policy brings positive impact on profitability in Indian banking sector.

Table: 5.22

Descriptive Statistics of Risk Efficiency				
	Mean	Std. Deviation	Minimum	Maximum
2005	0.611	0.224	0.377	1.418
2006	0.645	0.174	0.433	1.204
2007	0.654	0.122	0.465	0.927
2008	0.669	0.144	0.442	0.949
Grand Frontier	0.645	0.141	0.451	1.008

Descriptive Statistics of Risk Efficiency suggests that the Indian banks are gradually becoming more efficient in risk management i.e. safer as indicated by steady increasing trend in mean scores and decreasing trend in SD and range of risk efficiency scores.

5.4.2.2: Overall Ranking

Now we go for overall rankings for each year and for the study period based on composite index obtained for each bank. Composite index calculation procedures are discussed in earlier of this section of analysis.

Table: 5.23

Bank Wise Overall Ranking

Banks	2005	2006	2007	2008	2005-08
ALB	22	20	8	12	18
ANB	4	16	19	17	17
BOB	25	26	34	30	28
BOI	34	31	30	16	30
BOM	30	32	31	28	32
CAB	23	11	21	23	21
COB	10	14	13	7	13
DEB	31	25	27	29	29
IDL	7	7	5	11	9
IOB	16	10	3	9	8
OBC	2	8	18	22	12
PNB	14	13	16	15	16
SYB	27	24	26	21	25
UCB	29	33	35	36	35
UBI	11	18	11	8	11
VJB	9	23	23	25	20
SBI	24	21	25	27	24
SBJ	18	22	20	24	22
SBM	12	15	15	19	19
SBT	15	19	7	3	3
BOR	35	36	24	33	34
CUB	13	6	10	5	6
DLB	36	35	36	34	36
FDB	26	12	4	6	14
IVB	35	28	33	32	33
JKB	19	17	12	14	15
KTB	6	3	14	18	7
KVB	17	5	2	1	2
LVB	28	34	32	31	31
SIB	32	29	29	20	27
AXB	20	9	9	4	10
CBP	21	27	22	33	26
HDB	1	1	1	2	1
ICB	5	4	6	10	5
IIB	8	30	28	26	23
KMB	3	2	17	13	4

Table: 5.24

Overall Rank-wise Banks (2005-08)

Rank	Banks	Rank	Banks	Rank	Banks	Rank	Banks
1	HDB	10	AXB	19	SBM	28	BOB
2	KVB	11	UBI	20	VJB	29	DEB
3	SBT	12	OBC	21	CAB	30	BOI
4	KMB	13	COB	22	SBJ	31	LVB
5	ICB	14	FDB	23	IIB	32	BOM
6	CUB	15	JKB	24	SBI	33	IVB
7	KTB	16	PNB	25	SYB	34	BOR
8	IOB	17	ANB	26	CBP	35	UCB
9	IDL	18	ALB	27	SIB	36	DLB

HDB is the most efficient bank based on composite index of the three parameters over the study period and least efficient DLB. Though ICB, KMB. KTB rank within the first ten banks as per overall rankings (2005-08), year wise overall rankings indicate that their ranking positions are gradually deteriorating particularly in 2007 and 2008 where as ALB, BOI, COB, UBI, SBT, CUB, FDB, KVB, and AXB are gradually improving their ranking position during the study period. Sample banks based on overall rankings (2005-08) can be grouped as follows-

Table: 5.25

Bank Groups as per Overall Rankings (2005-08)

Bank Groups	Public Banks (number of Banks)	Private Banks (Number of Banks)
First 12 banks (Highly Efficient Banks)	6 (30%)	6 (37.5%)
Next 12 banks (Medium Efficient Banks)	9 (45%)	3 (19.25%)
Last 12 banks (Low Efficient Banks)	5 (25%)	7 (43.75%)
Total Sample Banks (36)	20 (100%)	16 (100%)

From this facts, it is clear that private banks dominates both in highly and low efficient bank groups but public banks in the medium efficient group. On the whole among the first 24 efficient banks there are 15 banks, i.e. 75% of the public banks and 9 banks i.e. 56% from private sector banks. Public banks are ahead of private banks as far as overall efficiency (DEA plus Financial) is concerned.

Box No: 5.3

First 10 Banks

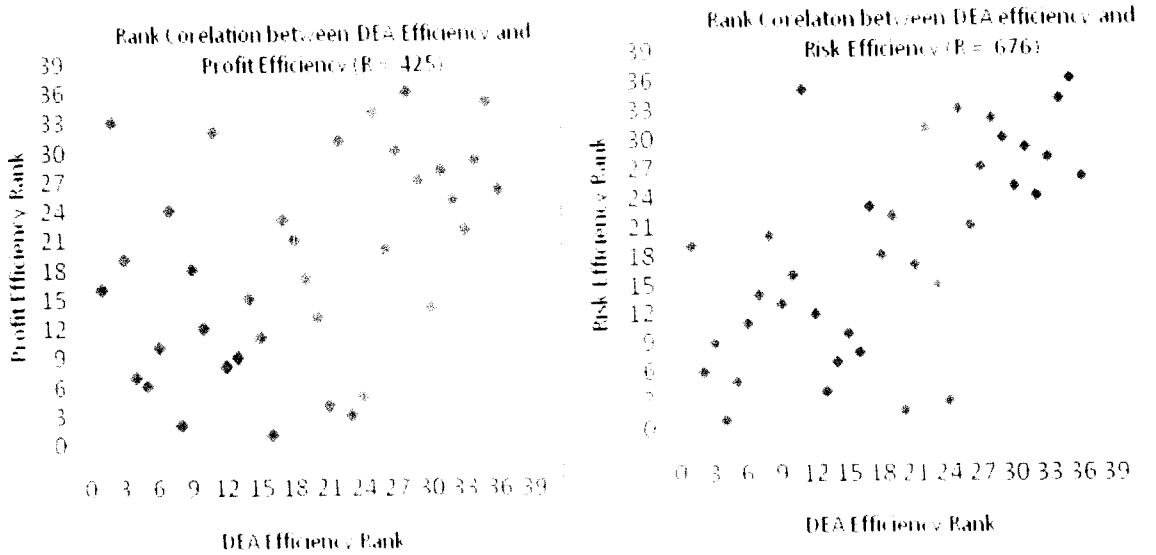
Technical Efficient Banks	Profitable Banks	Secured Banks
1 ICB	1 IOB	1 HDB
2 IDL	2 CUB	2 PNB
3 KMB	3 SBM	3 ANB
4 HDB	4 ALB	4 KTB
5 KVB	5 ANB	5 KVB
6 SBT	6 KVB	6 IDL
7 JKB	7 HDB	7 COB
8 CUB	8 AXB	8 IOB
9 OBC	9 KTB	9 KMB
10 UBI	10 SBT	10 FDB

Note: first ten banks are based on the scores over the study period of the respective three parameters considered for overall rankings 2005-08.

5.5: Financial Efficiency vs. Technical Efficiency

For overall rankings, the study has relied on technical as well as financial efficiency. Technical efficiency (TE) is measured by the economic measure – DEA and financial efficiency (FE) i.e., profit and risk efficiency by the accounting measure – financial ratios (see Box No: 5.2). In this section we are trying to examine whether the banks which are financially efficient are technically efficient or not. This relationship also helps to gain insight into various financial dimensions and to explore the financial operational strategy that makes the banks technically efficient

Figure: 5.9



Note: DEA efficiency = super efficiency (grand frontier), profit and risk efficiency are the average efficiency over the study period. R- Rank Correlation.

The analysis from Figure: 5.9 suggest that there is a positive and significant relation between TE and FE. From this finding, it can also be said that efficiency of economic measures substantiate the results arrived at through the accounting measures.

Table: 5.26

Mean Scores of Profit and Risk Efficiency between Efficient and Inefficient Bank Groups with F-value

DEA Groups	N	Profit Efficiency		Risk Efficiency				
		ROE	ROA	CAR	AQY	LDY	MQY	RI
Efficient banks	16	0.674	0.807	0.860	0.602	0.711	0.931	0.420
Inefficient banks	20	0.601	0.547	0.789	0.539	0.675	0.772	0.210
Total	36	0.634	0.663	0.820	0.567	0.691	0.842	0.303
F value		0.958	**13.351**	**9.873**	0.202	0.559	**17.929**	**5.871**
Sig		0.335	**0.001**	**0.003**	0.656	0.460	**0.000**	**0.021**

Note: DEA groups are based on grand frontier scores. Efficiency of each component is calculated by averaging the scores of four years of the respective component. N = Number of banks

Table 5.26 shows the mean scores between DEA efficient and inefficient bank groups on the various components based on which profit and risk efficiency over the study period are calculated. Financial analyst, bankers, bank supervisor and many researchers widely use these indicators to measure a bank's financial health. Table 5.26

clearly shows that efficient banks i.e., fully technically efficient banks have higher efficiency in all the components of financial health. F value in one-way ANNOVA indicates that there is a significant difference in mean financial attributes indicated by the four factors namely ROA, CAR, MQY and RI between these two groups of banks.
So, relationship with other performance metrics reveals that efficient banks in comparison to inefficient banks have

- ✓ Greater Utilization of Assets (ROA)
- ✓ Higher Capital Adequacy Ratio (CAR)
- ✓ Lower operating cost to operating income (MQY)
- ✓ Lower risky (RI)

Thus, this analysis summarizes that banks which has higher net worth (i.e. lower financial leverage) with higher management skill or operational skill tend to invest more fund in loans to earn more income for profit maximization and such a financial operating strategy makes them DEA efficient. On the whole, well capitalized profitable Indian banks are the efficient banks over the study period.

5.6: Categorization of Banks: Risk-Return Matrix

Categorization of banks and ranking helps to obtain an enhanced picture of the sample banks' performance and to highlight the potential performance improvement that management might be able to implement, accelerating overall efficiency.

For categorization, the relationship between Technical Efficiency, Profit efficiency and Risk Efficiency is explored. Previous study shows the relationship between efficiency and profitability of units with the help of 'efficiency-profitability matrix' as suggested by Boussifiane and Dyson[72] (1991); Camanho and Dyson[73] (1999); Avkiran[74] (2006) and Kumar[75] (2008). But in this study we use 'risk- return matrix' for efficient banks and inefficient banks separately, which facilitates categorization of efficient and inefficient banks. Efficient banks and inefficient banks are identified on the basis of grant frontier results (2005-08) under CCR model. For risk-return matrix, four

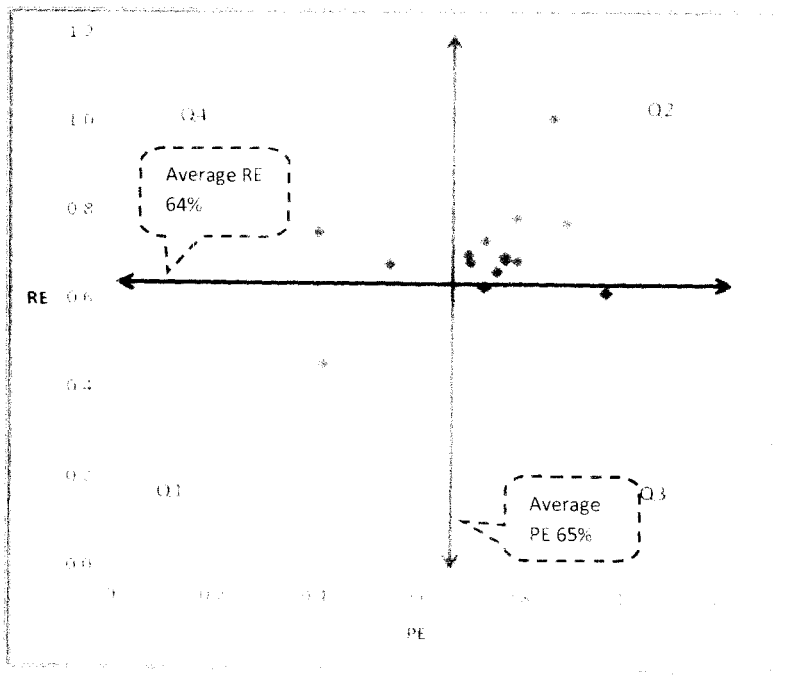
years average scores of profit efficiency (PE) and risk efficiency (RE) are considered. This analysis also helps to examine whether risk and return efficiency (i.e. financial efficiency) are sensitive to technical efficiency (CCR efficiency).

5.6.1: Categorization: Efficient Banks

The following risk-return matrix (Figure 5.10) is divided in four quadrants where 16 fully (100%) technical and scale efficient banks of different profiles are likely to exist. These four quadrants divide the efficient banks into four categories.

Figure: 5.10

Risk-return Matrixes for Efficient Banks



RE- Risk Efficiency, PE -Profit efficiency, Average is calculated based on total number of sample banks.

Banks in Quadrant 2 (Q2) are actually all round efficient banks ,super star banks since they are efficient in all the three parameters of efficiency (TE, PE and RE). Thus these banks are most suitable for others to benchmark and can become role models for inefficient banks and other efficient banks.

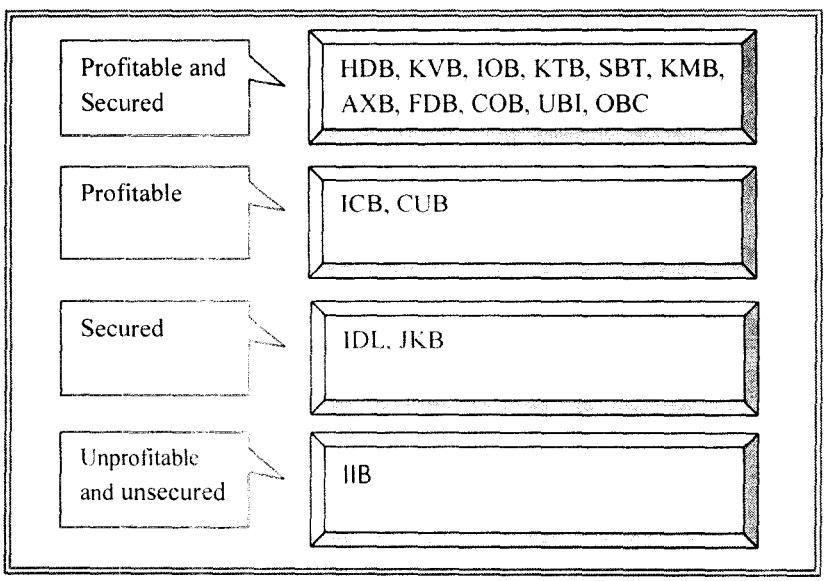
Banks of Q3 are profitable and technically efficient banks but are relatively risky banks i.e., efficient banks with relatively high profit high risk banks. They should follow efficient banks falling under Q2 and Q4 for improving their risk management ability.

Banks in Q4 are the banks that are efficient both from the point of view of conversion of input into output (TE) and risk management (RE) but are relatively less profitable. That is efficient banks with relatively low risk low profit banks. These banks are actually conservative banks. They should concentrate on lending activities rather than savings. They can adopt a different product mix for improvement of the profitability level. They can extend their business by opening new branches to capture the more business. They should follow efficient banks falling under Q2 and Q3 for improving their profitability position.

Q1 banks are only technically efficient but inefficient both in profitability and risk management i.e. lower profit higher risk banks. This is not expected. They are actually marginally efficient banks or efficient banks by default. Their efficiency strength is low. Therefore the possibility of being struck off the 'DEA- efficient' status of these banks is very high.

Box: 5.4

Four Categories of Efficient Banks

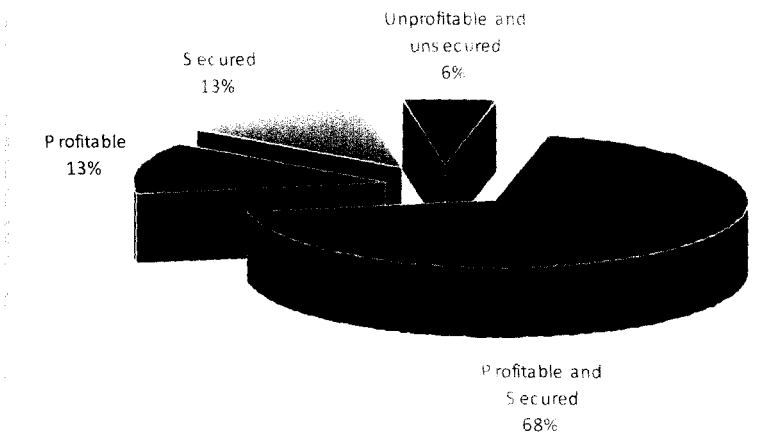


Note: Banks are arranged as per overall ranking position (2005-08)

Here it is pointed out that the precise boundary positions between quadrants are subjective. Thus, ICB and CUB of Q3 are lying just below the risk free zone. Thus, they may be treated as all round efficient banks. Only that their risk management is relatively low by some little extent in comparison to the banks of Q2.

Figure: 5.11

Category Wise Number of Efficient Banks (%)



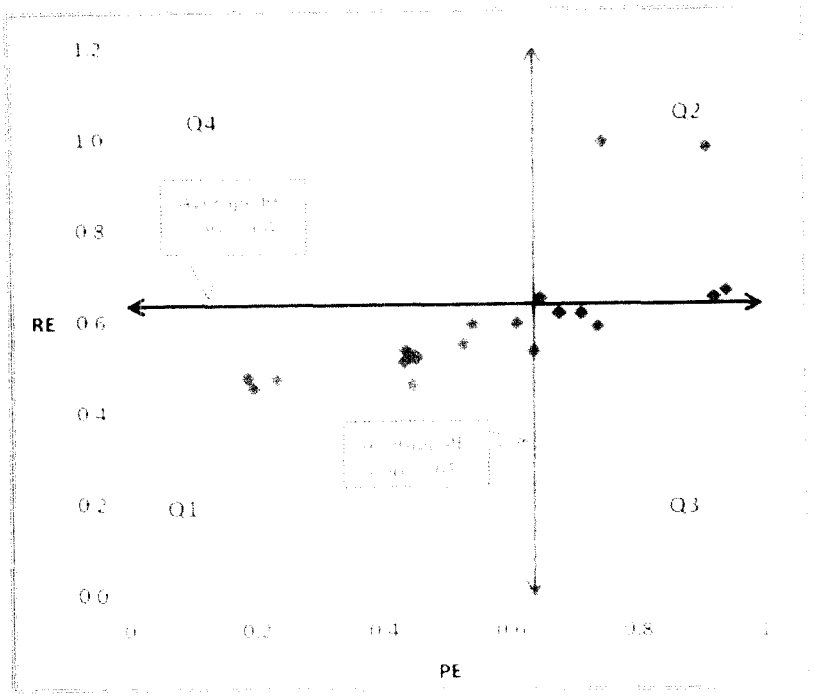
From the above figure 5.11 it is very clear that the majority of efficient banks are in quadrant 2. This implies that distribution of efficient banks with respect to risk-return matrix is skewed to right upper quadrants (Q2). This finding proves that technically efficient (DEA) banks are also financially efficient ones. It is also observed 81.3% (Q2+Q3) of the efficient banks are profitable and 81.3% (Q2+Q4) are low risky banks. So most of the efficient banks are profitable and safer indicating higher profitability and lower risk is related with higher technical efficiency.

5.6.2: Categorization-Inefficient Banks

In the same way same risk-return matrix divides the 20 inefficient banks (OTE<1) into four categories.

Figure: 5.12

Risk-return Matrix for Inefficient Banks



Banks in the Q2 have the highest level of technical, profitability and risk efficiencies within the inefficient banks group. These banks are actually marginally inefficient banks having OTE more than 90%. They are the prime candidates for a technical efficiency improvement effort.

The banks of Q3 are the lucky ones which are inefficient in utilizing their resources and are relatively risky but profitable. Their higher profitability may be for using higher financial leverage in capital structure. They are probably very aggressive in credit activities and this aggressiveness leads to higher variation in ROA. They can increase their efficiency level by strengthening capital position leading to greater profit.

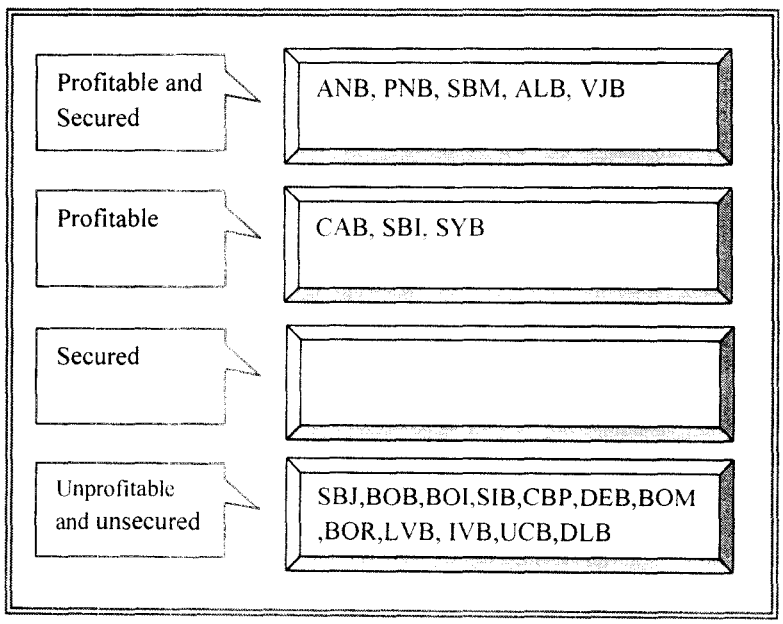
Q4 banks are the banks which are inefficient in resource utilization and less profitable but they have relatively stronger so far as risk management point of view. They may be conservative banks. It may happen that they may not use capital properly. There may be unnecessary block up of capital which may cause lower profitability. They should be very careful in lending activities rather than in savings. They should also explore off balance sheet activities for generating more revenue. Thus the banks of this category

should concentrate over the cost revenue management aspect leading to efficiency improvement.

The banks that fall in the first quadrant (Q1) are most inefficient in respect of three efficiency parameters. These banks are probably under-resourced and lack of skilled management. But they have the greatest potentiality for improvement in efficiencies by increasing management efficiency and using additional resources particularly more capital. For improvement of efficiency, they follow two stage peer banks -first banks of Q2 of inefficient banks group and then banks of Q2 of efficient banks group. First stage helps them how to increase profit and risk efficiency even being technically inefficient and second stage makes them technically efficient with higher profit and higher risk efficiency.

Box: 5.5

Four Categories of Inefficient Banks

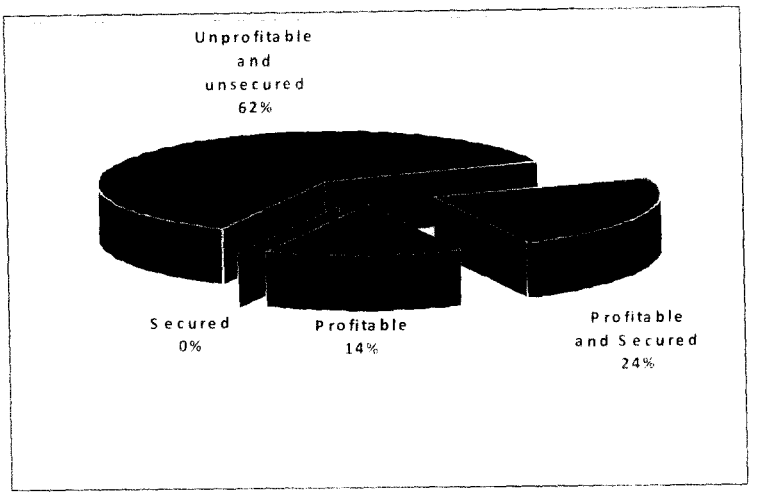


Note: Banks are arranged as per overall ranking position (2005-08)

CAB and SBI can also be placed into profitable and secured category since they are just lying below the risk free line.

Figure: 5.13

Category Wise Number of Inefficient Banks (%)



From the above figure 5.13 it is very clear that the most of the inefficient banks are in the groups of Q1 (most inefficient banks). This finding again proves that DEA efficiency is responsive to risk and return efficiency. On the whole 62% (Q1+Q4) of the inefficient banks are relatively less profitable, whereas, 75% (Q1+Q3) of the inefficient banks are risky. Most of the inefficient banks are facing the problem of risk management particularly in terms of operational inefficiency, instability in profit earning with low capital position in comparison to the efficient banks. Indian banking regulators should take this consideration for taking regulatory measures in order to improve their efficiency level. Thus, the categories of banks using risk-return matrix separately for efficient and inefficient banks helps to find out extreme and non-extreme group of banks from a sample of 36 banks.

Box: 5.6

Two Extreme Groups of Banks

Most Efficient Banks	HDB, KVB, IOB, KTB, SBT, KMB, AXB, FDB, COB, UBI, OBC
Most inefficient Banks	SBJ,BOB,BOI,SIB,CBP,DEB,BOM ,BOR,LVB, IVB,UCB,DLB

Note: Banks are arranged as per overall ranking position (2005-08)

11 banks out of 16 efficient banks over the study period lies on Q2 in Figure 5:11 and can be termed as most efficient banks. They are relatively profitable, secured and technically efficient banks i.e., all round efficient banks. 12 banks out of 20 inefficient banks over the study period lying on Q1 in Figure 5.12 can be termed as most inefficient banks. They are unsound in every respect. It is pointed out that BOI out of most inefficient bank group has been steadily improving its overall efficiency over the study period and has obtained 100% efficiency in PTE in 2008.

Table: 5.27

Mean scores of Profit and Risk Efficiency between two Extreme groups of Banks with F value

Groups	Profit Efficiency		Risk Efficiency				
	ROE	ROA	CAR	AQY	LDY	MQY	RI
Most Efficient Banks	0.735	0.864	0.860	0.728	0.699	0.945	0.468
Most Inefficient Banks	0.456	0.405	0.773	0.352	0.628	0.720	0.108
Difference	0.279	0.459	0.087	0.376	0.071	0.225	0.360
F value	14.837	66.112	7.445	13.571	2.314	24.370	10.249
Sig	0.001	0.000	0.013	0.001	0.143	0.000	0.004

There is a significant difference between these two groups of banks in all the micro parameters (except LDY i.e., liquidity) of profit and risk efficiency. This finding supports the earlier observation of positive significant relation between technical efficiency and financial efficiency and validates the finding of two extreme groups of banks from the sample banks.

This risk-return matrix highlights the importance of using more than one performance measure in order to obtain a better assessment of a bank as it is not possible to account for all aspects of banks' performance using a single indicator. From this analysis it becomes evident that some financial performance enhancement can still be achieved by the efficient banks. Inefficient banks can achieve higher overall performance by improving technical efficiency.

With this analysis, the study has finally concluded that these all round efficient banks are the India's efficient banks of 'Today'. From the trend of magnitude of

frequency in reference sets and year wise overall ranking position over the study period, the study is likely to predict that seven banks from the all-round efficient banks group viz. HDB, KVB, SBT, KMB, FDB, COB, UBI and three other banks viz. IDL, CUB and ICB which are on the verge of achieving the all round efficient bank status are the India's efficient banks of 'Tomorrow' unless there is a radical shift in their fortune.

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