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- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
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BANKING EFFICIENCY: APPLICATION OF DATA ENVELOPMENT APPROACH (DEA)

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ABSTRACT

The paper attempts to examine the efficiency of the banking sector in India. India being a developing country with wide industrial base relies heavily on the banks for their credit demands. There have been many previous studies which have considered different models for checking the efficiency of the banks. The prime focus was to measure the lending efficiency of the banks. This takes into consideration the model in which one can measure loans as output and assets and deposits as inputs. In other words how well banks are transferring funds from house-holds to the industries, thereby performing the basic task for which they have been conceived. From deposit mobilization to lending a comparison was made and found that there is no significant difference between private and public sector banks. Also there has not been significant increase in the efficiency of bank. The paper concludes that, as the economy grows and more and more opportunities come into the system banks must focus on increasing their efficiency so that they can provide a firm support in the financial market for the industries to develop.

KEYWORDS

DEA Model, Indian Banking Environment, non parametric.

GEL CODES

G21, G 15, C 12, N 1O, D 61.

PROLOGUE

Reserve Bank of India (RBI) was constituted as an apex bank without major government ownership. Banking Regulations Act was passed in 1949, with wide ranging powers for supervision, control, licencing powers and inspection of the banks .RBI acquired control of the Imperial Bank of India, which was renamed as State Bank of India. In 1959, SBI took over control of eight private banks floated in the erstwhile princely states, making them as its 100% subsidiaries.

RBI was empowered in 1960, to force compulsory merger of weak banks with the strong ones, this resulted in reduction of banks from 566 in 1951 to 85 in 1969. In July 1969, government nationalised 14 banks having deposits of Rs.50 crores and above, so that banks can play the role of catalytic agents for economic growth. The Narasimham Committee report suggested wide ranging reforms for the banking sector in 1992 to introduce internationally accepted banking practices.

REVIEW OF LITERATURE

Analysis of efficiency of financial institution has gained a lot of importance in the last few years. Various approaches have been defined to determine the efficiency of the financial institutions. These approaches broadly fall under two types-parametric and non parametric. The primary difference between these as explained by Berger and Humprey (1997), is the assumptions imposed on the data in terms of

a.   The functional form of the best practice frontier
b.   Consideration of random error
c.   If there is a random error the probability distribution assumed for the inefficiencies.

Thus the shape of the frontier and the distributional assumptions on the random error and inefficiency are key parameters on which the main approaches to determine the efficiency of financial institutions differs. The non parametric programming was initiated by Charnes et al. They gave relatively little specification of the best practice frontier as in the case of nonparametric approaches such as Data Envelopment Approach (DEA) and Free Disposal Hull (FDH). The most widely used nonparametric technique is DEA, as it is proven to be valuable tool for strategic, policy and operational problems, besides to develop benchmarks. At present, DEA has been widely accepted as a tool to measure the efficiency of the financial institutions over the parametric methods.

Bauer et al applied different approaches to the study of the efficiency of the US banks over the period 1977-88. They found that nonparametric methods were generally consistent with each other as far as identifying efficient and inefficient firms were concerned, but parametric and nonparametric measures were not consistent with each other.

The wide acceptance of DEA as a measurement tool for measuring efficiency of the financial institution can be attributed to certain strengths of this approach. The main advantages of using DEA are as follows. The data may not necessarily assume any functional form. DEA leads to a comparison of one Decision Making Unit against peer or combinations of peer. The units of input and output may vary as they do not affect the value of efficiency measure. This model can handle multiple inputs and outputs. However, there are a few limitations as well. There is no assumption of statistical noise, thus the noise element gets reflected in the measured inefficiency of the DMU. Further DEA does not give absolute efficiency measures. DEA results are sample-specific. An inherent limitation of this nonparametric method is that it makes hypothesis testing difficult.

THE CONSTANT RETURNS TO SCALE MODEL

Charnes et al. proposed this model with the assumption of constant returns to scale. It's also called the CCR model after the researchers Charnes, Cooper and Rhodes. The present study suggests that banks produce certain inputs to produce certain outputs. Thus, the efficiency of banks is measured in terms of how efficiently they are able to utilize their inputs given their outputs. In this model, efficiency is measured by the ratio of weighted outputs to weighted inputs. The ratio is of the form:

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$$\frac{u_1 y_1 + u_2 y_2 + \dots\dots\dots + u_n y_n}{v_1 x_1 + v_2 x_2 + \dots\dots\dots + v_n x_n}$$

Where, u and v are weights for outputs (y_1 .... y_n) and inputs (x_1 .... x_n) respectively. Assume that for each of the n firms there is a data on K inputs and m outputs and represented by column vectors x_i and y_i respectively for the ith firm. This may be expressed as u'y_i / v'x_i where u is MX1 vector of output weights and v is KX1 vector of input weights. To arrive at the optimal weights, we define the following linear programming model as:

Max $_{u, v}$ (u'y_i / v'x_i)

Subject to, u'y_i / v'x_i ≤ 1,   j=1, 2, 3, ...n.

u,v ≥ 0   .....(1)

Solving Eq. 1, values for u and v may be obtained such that the efficiency measure for each firm is maximised. A pertinent constraint with this model formation is that it can have infinite number of solutions. Thus an additional constraint is added, v'x$_i$=1, so the problem can be removed. The new model, known as the transformation model, thus becomes

Max $_{u, v}$ (u'y_i)

Subject to, v'x_i = 1

u'y_i - v'x_i ≤ 0,   j=1, 2, 3, ...n.

u,v ≥ 0   .....(2)

This form in Eq. 2, is known as the multiplier form of the DEA linear programming problem. Using duality in linear programming, an equivalent envelopment form of this problem may be obtained.

Max $_{Θ, λ}$ (Θ)

Subject to, -y_i + Yλ ≥ 0

Θx_i - Xλ ≥ 0,   j=1, 2, 3, ...n.

λ ≥ 0   .....(3)

where, Θ is scalar and λ is a NX1 vector of constraints.
The efficiency for the jth DMU is reflected by the value of Θ.
For each DMU taken in study a separate linear programming model would be solved. The technically efficient DMU will have a Θ=1, and all other DMU will have a Θ < 1, implying that the efficiency scores of all other DMU's will be measured relative to the technically efficient units that have a score of Θ=1. In this study, each bank under observation is considered a DMU.

RESEARCH METHODOLOGY
The paper evaluates the technical efficiency of the banks operating in India using the DEA methodology. An important aspect in the dynamic business environment, in the wake of continuous reforms initiated by the RBI, is that the efficiency scores may vary from year to year. Hence a separate frontier was derived for each of the years taken during the study period.

CHOICE OF INPUT AND OUTPUT
It has been a matter of constant debate when it comes to defining inputs and outputs. There are mainly two approaches that have been discussed in existing literatures. The first is the **'intermediation approach'.** Here banks are viewed as intermediaries between the provider of the funds and users of the funds. In this approach, deposits are regarded as being converted into loans. This approach takes into account interest expense, which accounts for a large proportion of bank's cost. In this approach, output may be taken as money value of deposits and loans, and the inputs considered include money value of labour, fixed assets and equipments, and loanable funds. In contrast the second approach, **'production approach'** is the one in which banks are considered to be producing deposits and loans using capital and labour. This approach takes into account physical quantities of input and output, and does not assign monetary value to inputs or outputs. This approach does not take into account the interest costs, hence the criticism. The paper uses the second approach.
The data has been mostly secondary data i.e. collected from various places like, Prowess, BSE website, reports published by Govt. of India, Annual Reports of Banks etc.

SAMPLING UNIT
The banking index of BSE i.e. BANKEX served as the sampling for the data because it is a robust measure for measuring the performance of the banking sector of India. It has been scientifically designed and therefore provides the basis for the calculations and functions used to analyse the data. The study is based on a period of six years i.e. 2004-2009. Thus all the data used pertains to the same period.

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ANALYSIS AND INTERPRETATION OF DATA
EFFICIENCY OF BANKS

	RANKING ON THE BASIS OF AVERAGE	RANKING ON THE BASIS OF THE LAST YEAR
1	IDBI	Kotak Mahindra
2	Oriental Bank	Yes Bank
3	Kotak Mahindra	ICICI
4	Yes Bank	IDBI
5	Bank of India	Axis Bank
6	Indian Overseas Bank	Federal Bank
7	Canara Bank	IndusInd
8	Karnataka Bank	Karnataka Bank
9	Punjab National Bank	Indian Overseas Bank
10	Union Bank of India	Canara Bank
11	State Bank of India	Bank of Baroda
12	Federal Bank	Bank of India
13	ICICI	Punjab National Bank
14	Bank of Baroda	HDFC
15	Allahabad Bank	Union Bank of India
16	Axis Bank	Oriental Bank
17	HDFC	Allahabad Bank
18	IndusInd	State Bank of India

On the basis of average performance of the five years IDBI, Oriental Bank and Kotak Mahindra were top performers. But if the last year's performance is seen then Kotak Mahindra, ICICI and Yes Bank has fared well. One of the most worst performing bank has been SBI which scored last on the previous year and eleventh on the average.

PUBLIC VS PRIVATE BANKS (GROUP STATISTICS)

	public_vs_private	N	Mean	Std. Deviation	Std. Error Mean
Efficiency	Public	60	.7473	.16376	.02114
	Private	48	.7360	.20098	.02901

So far as the difference in performance of the private sector and public sector banks are concerned very significant differences were not found. In terms of giving loans both public sector and private sector banks have performed equally.

INDEPENDENT SAMPLES TEST

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Efficiency	Equal variances assumed	.942	.334	.320	106	.749	.01124	.03509	-.05833	.08081
	Equal variances not assumed			.313	89.968	.755	.01124	.03590	-.06008	.08255

BANK WISE: Dependent Variable: efficiency

(I) company_wise	(J) company_wise	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
IDBI	Allahabad bank	-.34990[*]	.16583	.038	-.6794	-.0204
	Axis bank	-.33788[*]	.16583	.045	-.6673	-.0084
	Bank of Baroda	-.37689[*]	.16583	.025	-.7063	-.0474
	Bank of India	-.49539[*]	.16583	.004	-.8248	-.1659
	Canara Bank	-.47344[*]	.16583	.005	-.8029	-.1440
	Federal Bank	-.41244[*]	.16583	.015	-.7419	-.0830
	HDFC	-.28865	.16583	.085	-.6181	.0408
	ICICI	-.40662[*]	.16583	.016	-.7361	-.0772
	Indian Overseas Bank	-.47543[*]	.16583	.005	-.8049	-.1460
	IndusInd	-.24542	.16583	.142	-.5749	.0840
	Karnataka Bank	-.44317[*]	.16583	.009	-.7726	-.1137
	Kotak Mahindra	-.53137[*]	.16583	.002	-.8608	-.2019
	Oriental Bank	-.55142[*]	.16583	.001	-.8809	-.2220
	PNB	-.43633[*]	.16583	.010	-.7658	-.1069
	SBI	-.42129[*]	.16583	.013	-.7507	-.0918
	Union Bank of India	-.42387[*]	.16583	.012	-.7533	-.0944
	Yes Bank	-.52431[*]	.16583	.002	-.8538	-.1949

IDBI has performed significantly different from all other banks but in a negative sense.

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BANKEX VS SENSEX REGRESSION

As observed by the graph there exists a very high correlation between Sensex and Bankex, this is due to the fact that banking and economy are very closely related and hence they follow each other closely.

REGRESSION

Regression Statistics		Coefficients	
Multiple R	0.977975708		
R Square	0.956436486	β_0	-327.5508226
Adjusted R Square	0.95587798	β_1	0.555338589
Standard Error	543.4932694		
Observations	80		

Depending on the Sensex one can predict the Bankex future as

*Bankex = 327.5508226 + 0.555338589 * Sensex*

YEAR WISE COMPARISON: On applying T-test it was found that there is not much significant difference in efficiency between the years except for the year 2004 and others. This explains that banks have not been increasing their efficiency and continue to go at the same pace. **Descriptive**

EFFICIENCY

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
2004.00	18	.5836	.24590	.05796	.4613	.7059	.00	1.00
2005.00	18	.7428	.17750	.04184	.6545	.8310	.47	1.00
2006.00	18	.7442	.13222	.03116	.6785	.8100	.49	1.00
2007.00	18	.8088	.11678	.02753	.7507	.8668	.58	1.00
2008.00	18	.8366	.12097	.02851	.7764	.8967	.60	1.00
2009.00	18	.7376	.16264	.03834	.6567	.8185	.40	1.00
Total	108	.7423	.18045	.01736	.7078	.7767	.00	1.00

ANOVA

EFFICIENCY

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.693	5	.139	5.067	.000
Within Groups	2.791	102	.027		
Total	3.484	107			

MULTIPLE COMPARISONS

DEPENDENT VARIABLE: EFFICIENCY

	(I) year	(J) year	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**2004.00**	2005.00	-.15912[*]	.05514	.005	-.2685	-.0498
		2006.00	-.16059[*]	.05514	.004	-.2700	-.0512
		2007.00	-.22513[*]	.05514	.000	-.3345	-.1158
		2008.00	-.25296[*]	.05514	.000	-.3623	-.1436
		2009.00	-.15398[*]	.05514	.006	-.2633	-.0446

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FUTURE PREDICTIONS

	Life sciences	Food and Agriculture	Infra	Engineering	Technology media and telecommunication	Others
Growth	**9.5**	**9**	**17**	**15**	**7**	**11**
2008-2009	1	1	1	1	1	1
2009-2010	1.095	1.09	1.17	1.15	1.07	1.11
2010-2011	1.199025	1.1881	1.3689	1.3225	1.1449	1.2321
2011-2012	1.312932	1.295029	1.601613	1.520875	1.225043	1.367631
2012-2013	1.437661	1.411582	1.873887	1.749006	1.310796	1.51807
2013-2014	1.574239	1.538624	2.192448	2.011357	1.402552	1.685058
2014-2015	1.723791	1.6771	2.565164	2.313061	1.50073	1.870415

The following sectors are the sunrise or priority sectors of the Indian Market. Either they do not have investors ready or they are being developed by govt. The banking sector has more or less neglected the growth opportunities in these sectors. Based on the different statistics predicted by Govt. of India and McKinsey, the various growth rates have been taken into consideration and growth predicted at the given rates predict that by 2015 banking sector is going to grow at about twice the volume it is operating at now.

Year		Life sciences	food and agriculture	Infra	Engineering	Technology media and telecommunication	Others
2008-2009		**7**	**22**	**15**	**17**	**13**	**26**
	percent share	0.07	0.22	0.15	0.17	0.13	0.26
2009-2010	increase	7.665	23.98	17.55	19.55	13.91	28.86
	redistribute	7.80605	24.5333	16.72725	18.95755	14.49695	28.9939
2010-2011	increase	8.54762475	26.741297	19.5708825	21.8011825	15.5117365	32.183229
	redistribute	8.70491666	27.3583095	18.6533928	21.1405119	16.1662738	32.3325476
2011-2012	increase	9.53188374	29.8205573	21.8244696	24.3115887	17.297913	35.8891278
	redistribute	9.70728781	30.5086188	20.801331	23.5748418	18.0278202	36.0556404
2012-2013	increase	10.6294802	33.2543945	24.3375573	27.1110681	19.2897676	40.0217609
	redistribute	10.825082	34.0216863	23.1966043	26.2894849	20.1037237	40.2074474
2013-2014	increase	11.8534648	37.0836381	27.140027	30.2329076	21.5109844	44.6302667
	redistribute	12.0715902	37.9392835	25.8676933	29.316719	22.4186675	44.837335
2014-2015	increase	13.2183913	41.353819	30.2652011	33.7142269	23.9879742	49.7694419

But the problem with the previous growth model was that all the sectors are not capable of absorbing the same amount of funds, hence there are funds that are left unused. The solution could be that the funds at the end of each year are invested at the ratio in which they are invested now.

CONCLUSION

Conclusion: On the efficiency frontier it can be said with reasonable certainty that there is not much significant difference in efficiency between the years except for the year 2004 and others. This explains that banks have not been increasing their efficiency and continue to go at the same pace. So far as the difference in performance of the private sector and public sector banks are concerned very significant differences were not found. In terms of giving loans both public sector and private sector banks have performed equally. It was also found that there exists a very high correlation between Sensex and Bankex, this is due to the fact that banking and economy are very closely related and hence they follow each other closely.There is significant difference in the efficiencies of IDBI and other banks.This is due to the fact that IDBI being development bank has the backing of the Govt. So far as the comparison of investment patterns in different industries e.g. life sciences, food and agriculture, infrastructure, engineering and technology media and telecommunication is concerned it was found that the banking sector will outshine all the sectors in terms of its growth . The banking sector is expected to grow at double the present rate of growth.

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TABLES

WEIGHTAGE OF BANKEX			
Company Name	**Weight**	**Company Name**	**Weight**
Allahabad Bank	1.16	IndusInd Bank	1.19
Axis Bank	8.87	IOB	0.94
Bank of Baroda	4.15	Karnataka Bank	0.27
Bank of India	3.42	Kotak Mahindra	5.03
Canara Bank	3.13	Oriental Bank	1.34
Federal Bank	0.86	PNB	5.54
HDFC Bank	15.13	SBI	24.46
ICICI Bank	18.94	Union Bank	2.52
IDBI Bank	1.68	Yes Bank	1.39

EFFICIENCY TABLE

Company Name/Efficiency	2004	2005	2006	2007	2008	2009
Allahabad Bank	0.640503	0.584424	0.632959	0.711209	0.778168	0.60624
Axis Bank	0.389283	0.554466	0.575388	0.696776	0.820669	0.844845
Bank of Baroda	0.571634	0.690338	0.694272	0.75915	0.735742	0.664297
Bank of India	0.769933	0.939401	0.781902	0.862828	0.808778	0.663633
Canara Bank	0.812495	1	0.814977	0.679329	0.71796	0.669979
Federal Bank	0.502876	0.57477	0.732077	0.799839	0.885867	0.833357
HDFC	0.435717	0.570774	0.592259	0.676841	0.666486	0.643945
ICICI	0.319067	0.471368	0.73667	0.836302	0.930442	1
IDBI	1	0.579917	-0.08682	-1.54	1	0.901025
Indian Overseas Bank	0.671538	0.813491	0.783509	0.823564	0.937579	0.677043
IndusInd	0.366822	0.533982	0.487329	0.576168	0.604741	0.757602
Karnataka Bank	0.674002	0.851676	0.680292	0.789089	0.797589	0.720501
Kotak Mahindra	0.402458	0.766222	0.873656	1	1	1
Oriental Bank	1	1	0.767604	0.839931	0.93557	0.619558
Punjab National Bank	0.701576	0.843031	0.701413	0.803628	0.773594	0.64884
State Bank of India	0.646781	0.792362	0.747745	0.864662	0.934084	0.396234
Union Bank of India	0.600647	0.803287	0.793875	0.838291	0.731377	0.629873
Yes Bank		1	1	1	1	1

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