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Effect of Financial Crisis in Efficiency and Strategic Homogeneity of Indian Commercial Banks: An Empirical Investigation

Subroto Chowdhury
National Institute of Bank Management

Abstract

The financial crisis has send shock waves cutting across boundaries and economies. Major economies are still struggling to recover. The cause of the crisis was primarily the inefficiency of the banking system to manage their sub - prime asset class. It reflected the importance of efficiency of the banking system irrespective of the credit rating which signifies its quality of asset class. In the contemporary world economy no economic system can remain isolated. Indian banking system also felt the shock but managed it efficiently. This motivates for a comprehensive analysis to discover whether the so called resilience was due to some policy stimulus or the Indian banking industry is intrinsically efficient. Also, the pattern of grouping of the banks plays an important role in providing stability in the inter-connected system. Thus technical analysis of the banks along with the dynamics of cluster formation after factoring the pre and post financial crisis time periods was studied , so that it can provide valuable inputs in designing strategic outlook regarding the Indian banking industry.

Keywords: Technical Efficiency, DEA, Indian Commercial Banks, Cluster Analysis

JEL Classification: C-61, H-21, G-21, C-83

1. Introduction

The world economy was shocked by the global financial crisis triggered by sub-prime crisis during the year 2008. All the major economies were shaken to their roots calling for intervention from the government and major changes in the policy measures. To be very simple in approach, the major cause of the financial crisis can be factored to the inefficiency of the banks in managing their assets class. Much studies and discussion since then poured in to find the causes and consequences of this crisis and the ways to avert this kind of crisis in future. Risk management again demanded prime attention although issues regarding the effectiveness of the risk management model remain. However amidst all the chaos some of the worlds growing economies were less effected, although shocks were felt across boundaries. Indian banking industry exhibited the resilience and robustness to withstand the financial shock. Although it is absolute naïve to comment that Indian banking industry was insulated against the shocks but it can be surely said that Indian banking industry managed the shocks more efficiently. This assertion calls for a detailed analysis to find out whether the so called resilience was due to some policy stimulus or the Indian banking industry is intrinsically efficient.

In the universe certain law of attraction prevails. Physics applies this kind of law and breaks in new frontiers giving the wide perspectives beyond horizons. The operation of the banking entities are not beyond the universe and hence cannot escape the natural laws operating within the dynamics of interaction. To put in more manageable sense the strategic homogeneity of the banks are also affected by factors within which they are operative. Grouping and regrouping is a natural phenomenon based on certain rules. Thus this kind of an understanding calls for deliberation to find out whether financial crisis has played any role in determining the factor motivating formation of clusters. Marketing as a process always looks for clusters based on certain homogeneity of variables so as to design techniques and means thus maximizing reach and minimizing transaction cost. The formation of clusters and the affinity of certain units to cling to the same clusters can always provide with the much needed vital tip.

Banking sector in India has witnessed major institutional alterations, and several policy reforms have been initiated to provide it with functional and operational autonomy. The basic aim of the reforms was to provide the banking sector the much needed space for proving its worth and become at par with the international standards. Thus the banking scenario in India transformed itself with operational freedom and technological outlook. Still, several issues remain. The banking sector in India is exposed to international competition with entry of large number of foreign banks and interest of private parties in setting banking business. Also the recent drive for financial inclusion for inclusive growth motivated the policy makers to consider ways and means to bring in more banking entities in the financial sector.

As banking is a complicated and specialized task- the measurement of its performance also calls for specialized approach. Efficiency in banking is a critical issue requiring some technical deliberation. Unlike the typical firm banks does not produce single output/product rather it is a multi-product producing firm. Thus the usual yardsticks of measuring efficiency are not apt for measuring the efficiency of the banks. Broadly efficiency of banks can be measured in accounting measures and economic measures. The use of various financial ratios that center on one or more outputs and their relevant inputs to measure the performance or productivity of a banking unit is referred to accounting measure. In economic sense- efficiency, as a normative concept, can also be measured by comparing the bank's performance as the ratio of output to inputs. The standards of comparison can be set by the units comprising the arena of comparison.

Efficiency measurement assumes importance because it acts as indicators signaling the strength and weakness of the banking system so as to make the regulator aware of the evolving situation and design corrective steps. Thus efficiency measurement of the banking system has been the area of interest for empirical financial economic research. It is also pointed out in the empirical study that banks getting high efficiency scores are more likely to survive than banks which have relatively low scores (Barr and Siems, 1996). Efficient functioning of banking sector is imperative for the efficient functioning of the economy and fueling the growth engine. The focus of bringing in new players in the banking sector calls for taking stalk of the already existing players and their efficiency. Thus, efficiency measurement of banks is very important for policy makers, industry leaders and many others who are reliant on the banking sector. Based on the above mentioned premises this empirical study is conducted so as to ascertain the technical efficiency of the Indian commercial banks.

2. Review of Literature

Few studies can be cited from international literature that addresses companies' financial performance using multivariate statistical techniques such as cluster analysis, principal components analysis, discriminant analysis and factor analysis. The power of the cluster in explaining companies' growth and their survivorship rates on the market along with cluster building mode in the financial services industry in Great Britain is studied (Pandit, Cook, Swann, 2001). While Fifield et al. (2002) used principal component analysis to find out the global and local factors that can explain the returns on the emerging markets. In order to analyze the missing data and identify homogenous groups in the interior of the available data cluster modeling of financial data is applied (Bensmail and DeGennaro, 2004). The factors influencing returns on the Indian capital market was studied using principal components analysis (Dhankar and Singh, 2005). Sueyoshi (2005) used non-parametric discriminant analysis and analyzed the financial performances of a number of 147 companies by assigning a set of weights to a linear discriminating function which as a result generated a score as regard

to its belonging to a particular group. The success of an investment made in the selected 71 companies from the Australian capital market using a set of financial indictors was studied by Ganesalingam and Kumar (2001). The study brought forward a discriminatory rule which can explain the interrelation between the companies and the factors providing profitability. The rule henceforth was used to envisage the companies' stability and to construct diversified portfolios.

The Non parametric approach of measuring bank efficiency is applied in many studies in order to ascertain the efficiency of banks. During mid 1990- Kraft and Tirtiroglu (1998) used the stochastic frontier analysis (SFA) technique to determine the efficiency of Croatian banks. The study revealed the superiority in terms of efficiency of the newly organized private banks in compared to older banks. One of the Non parametric approaches- Data Envelopment Analysis (DEA approach) also finds its application in studies concerning the efficiency measurement of banks. Data Envelopment Analysis (DEA) was used by Vujcic (2002) to analyze Croatian bank efficiency during late 1990's signifying the efficiency of foreign banks and new banks. The study conducted by Nikiel and Opiela (2002) during late 1990 using distribution-free efficiency estimation found that the polish banks were more profit efficient but less cost efficient when compared to foreign banks operating in Poland. In turkey it was found that private banks were catching up with the public sector banks during the study period (Isik and Hassan, 2003).

Although several studies have been conducted to measure the efficiency of the banks in developed countries; few are associated with efficiency measurement of banks in developing economies. The study conducted by Claessens et al. (2001) takes into consideration both the developed and developing economies and compares the performance of eighty banks. The study revealed that during the period from late 1990s to mid 2000's the participation of foreign banks increased the performance of the domestic banks. Data Envelopment Analysis was also used to analyze the efficiency of U.S. banks operating internationally (Haslem et al, 1999). Several studies have analyzed the efficiency of Indian banks using several financial indicators and compared across several banks. In their study Sarkar et al. (1998) compared public, private and foreign banks in India to determine the effect of ownership type on different efficiency measures. Financial measures were used to measure operational efficiency of different categories of banks during the period 2002-03(Rammohan, 2002-2003). Most of the studies measuring efficiency concentrated mainly on cost, profit, and income or revenue efficiency. Productive efficiency of Indian commercial banks were measured in the study by Bhattacharya et al (1997) using DEA revealing the fact that Indian Public sector banks were the best performing banks, while the private sector banks were still evolving to emerge fully in the Indian banking scenario. Sathye (2001) compared the efficiency of Indian public sector banks using DEA informing that the public sector banks have a higher mean efficiency score as compared to the private sector banks in India. The effect of deregulation on the efficiency of banks in India was studied by Kumbhakar and Sarkar (2003). They came to the conclusion that the performance of private sector banks have increased considerably compared to the public sector banks as they were able to take advantage and responded fighting fit to the deregulation measures. Revenue maximizing efficiency of public, private and foreign banks in India, using deposits and operating costs as inputs, and loans, investments and other income as outputs was studied by Rammohan and Ray (2004). The study revealed that the public sector banks were more revenue efficient than the private sector banks. Four input variables (viz. deposits, borrowings, labor and fixed assets) and four output variables (viz. net interest income, non interest income, credits and investments) were considered to study the banking

efficiency using stochastic frontier production function model during the reform period, 1992-1999. The study demonstrated that while deposits played a (Shanmugam and Das, 2004). Indian banks during the period 2004-05 were not much differentiated in conditions of input- or output-oriented technical efficiency and cost efficiency. But, there were significant differences in terms of revenue and profit efficiencies (Das et al, 2004). DEA was used during the period 1997-2001 to study the efficiency of private, public, and foreign banks operating in India (Sanjeev, 2006). The study found that efficiency score and the non-performing assets were negatively correlated.

Although many studies are conducted to measure efficiency of banks in India, few studies have concentrated to find out the technical efficiency of Indian commercial banks during the recent times. The study conducted by Kumar and Gulati (2007) measured technical efficiency of public sector banks in India using two data envelopment analysis models, viz. the CCR model and Andersen and Petersen's super-efficiency models. Keeping in view the above mentioned premise the present study was conducted to measure the technical efficiency of selected Indian commercial banks using Data Envelopment Analysis (DEA) model to analyze the efficiency score of the selected banks.

3. Data and Methodology

In the present study Data Envelopment Analysis technique will be employed to determine the Technical efficiency (TE) both at Constant Return to Scale (referred to as TE CRS) and at Variable Return to Scale (referred to as TE VRS). The scale inefficiency is measured as the difference in the TE CRS and TE VRS score. And, the scale efficiency is measured as the ratio of TE CRS and TE VRS score. The technical efficiency score of the inefficient DMU will be further decomposed according to their inputs

significant role in producing all outputs, the technical efficiency of raising interest margin varied across the banks

and output .As we have considered input oriented model, it is always implied that in order to increase the efficiency the DMU should reduce there inputs (hence negative notation in the table) and increase their output (hence positive notation in the table). In regression analysis the exogenous and endogenous variables are designed at the outset to produce results which are definitive in nature. A priori restrictions on the interrelationship between the variables are already imposed. But in the present study the regression style of analysis was not demanded for keeping in view the nature of the study. More natural agglomeration of the banks based on their DEA efficiency score was desired to be studied, hence, the choice of cluster Analysis. Cluster analysis imposes no a priori restriction and tries to form the groups based on their natural affinity. But cluster analysis is not free from limitations- the number of clusters formed may not be correct and the clusters formed from the data may not significantly represent different groupings (see Korobow and Stuhr, 1991). However this limitation in no way restricts the use of cluster analysis. Cluster analysis is used as a complementary tool to help diagnose the nature of the grouping of the banks. The output of cluster analysis is represented by two dimensional treelike diagrams called dendrogram. Dendrogram illustrates the fusions or partitions made at each successive stage of the analysis. It also exhibits the distance between the clusters after their fusion. In our study it was required to form the groups based on the similarity of the DEA efficiency score (acting as variable) and the distinction should be formed based on the outliers. Thus we have considered Squared Euclidean distance for the purpose of distance measurement. The rational is also supported by Wolfson et al. (2004) in a study of similar nature arguing that the "Squared Euclidean measurement places greater emphasis on outliers to

generate distance patterns".

Keeping in view the constraints of time and limitations of the study convenient sampling was done. All the banks listed under CNX Bank Nifty index were considered for the purpose of the study. It was assumed that the sample banks are enough to represent the entire banking industry in India. This can be considered as one of the limitation of the study. Based on the data availability, ten years data from 2000-2009 was collected form capitaline database. In order to find the effect of financial crisis on the efficiency and clustering of the banks, the study period is made into four distinctive blocks. The first block denoted by P1 is the average of years 2000-2007 and is the period immediately before financial crisis. The block P2 represents the year 2008, the year of financial crisis. Block P3 is the year immediately after financial crisis i.e. 2009. The last block P4 is the average of all the ten years 2000-2009.

3.1 Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is one of the widely used nonparametric approaches used for measuring efficiency of the firms. It is a non-parametric mathematical programming approach. The DEA model was first proposed by Charnes et al. (1978) mainly based on the idea and work of Farell (1957). DEA was later extended by Banker et al. (1984) to include features for determining efficiency more meaningfully. The firm whose efficiency is to be measured is called decision-making units (DMUs) in DEA parlance. The firms under study can use many inputs in order to create many outputs. But, In DEA analysis, relative measure of efficiency is calculated as the single virtual output to single virtual input. The single virtual input is a vector of all inputs while the single virtual output is the vector of all outputs considered for the production function. The DEA methodology assigns weights to each inputs and outputs which varies from firm to firm thus providing the relative efficiency of the firms in contrast to absolute efficiency. Thus, the efficiency scores are subjected to fluctuation with change in domain of comparison. Based on the technique of optimization, DEA constructs the piecewise efficient frontier. The DMUs either descend on the frontier or below it. The inefficiency of the DMU is measured by the distance of the DMU form the efficient frontier.

3.2 Models of DEA

Let there be n DMUs to be evaluated, requiring varying amounts of m different resources or inputs thereby producing s different outputs. We denote the DMUs by j = 1, 2,…., n. The parameters Xj = $\{x_{ij}\}$ and Yj = $\{y_{rj}\}$ constitute observed values and are constants. We also assume that $x_{ij} > 0$ and $y_{rj} > 0$. Where,

x_{ij} = Amount of i^{th} input required by the j^{th} DMU, where i = 1, …,m.

y_{rj} = Amount of r^{th} output produced by the j^{th} DMU, where r = 1, … , s.

X denotes the m x n matrix of inputs or resources.

Y denotes the s x n matrix of outputs.

The different DEA models tries to setup the subset of n DMUs, which in turn will determine parts of the envelopment surface and will thus form the efficient frontier. There are two types of orientation in DEA models. One is input orientation where, maximum amount of movement is made towards the frontier through proportional reduction of inputs, and the other is output orientation where, there is maximal movement towards the frontier via proportional augmentation of outputs.

3.3 Input Oriented CCR Model

The difficulty in using a common set of weights to determine relative efficiency was recognized by Charnes, Cooper and Rhodes (1978). According to

them each DMU should be allowed to adopt a set of weights that shows it in the most favorable light in comparison to the other units. And, thus formulated the famous CCR model and fundamentally developed the technique of Data Envelopment Analysis (DEA). CCR model reduces a multiple-output multiple-input situation to that of a single "virtual" output and a single "virtual" input situation. Mathematically denoted by,

Objective Function

Max $E_o = \sum_{i=1}^{k} UiYi\ o / \sum_{j=1}^{m} VjXjo$ ---------- (i)

Where,

O= The branch being assessed from the set of r=1, 2… n bank branches

K=Number of outputs at the branch

m=Number of inputs at the branch

Y_{ir}=Observed output i at branch r

X_{jr}=Observed input j at branch r

Constraints

$\sum_{i=1}^{k} UiYir / \sum_{j=1}^{m} VjXjr \leq 1$, r=1,2,….,n. ---------- (ii)

Ui,Vj>0 for i=1,2,…..,k and j=1,2,…..,n.---------- (iii)

The non negativity constraints can make the variables either positive or zero thus to make the variables strictly positive Charnes, et al (1979) replaced the restriction of the variables to be more than ξ, which is an infinitesimal or non-Archimedean constant, usually of the order of 10^{-5} or 10^{-6}.

Imposing , $\sum_{i=1}^{m} ViXio = 1$---------- (iv)

Max $Z_o = \sum_{i=1}^{s} UrYro$---------- (v)

Subject to , $\sum_{i=1}^{m} ViXio = 1$ ---------- (vi)

and

$\sum_{i=1}^{k} UiYio - \sum_{j=1}^{m} VjXjo \leq 0$ where r=1,2,……,n.- (vii)

Where,

Ui≥ξ for r=1,2,…..,k and Vj≥ξ for r=1,2,……,n.

3.4 Input Oriented BCC Model

Constant Returns to scale is one of the limitations of the input oriented CCR model. Thus the model was subsequently modified by .Banker, Charnes and Cooper (1984) and developed a modified but simple DEA model which took care of the returns to scale problem. The DEA model to handle Variable Returns to Scale (VRS) is known as BCC model. Mathematically it can be represented as,

Objective Function

Max $W_o = \sum_{i=1}^{k} UiYio + U_o$ ---------- (viii)

Subject to

$\sum_{i=1}^{m} ViXio = 1$ ---------- (ix)

$\sum_{i=1}^{k} UiYir - \sum_{i=1}^{m} VjXjr + U_0 \leq 0$ ---------- (x)

For r=1,2,……..,n.

And, $U_i \geq \xi$ for i=1,2,……,k

$V_j \geq \xi$ for j=1,2,……,m

U_o is free.

3.5 Efficiency of Firms

Efficiency of a particular firm can be defined as the degree to which the observed use of resources to produce outputs of a given quality matches the optimal use of resources to produce outputs of a given quality. It is assumed that a gap between the firm's actual and potential level of technical performance exist and thus measurement of technical efficiency of firms using frontier method is possible (Kalirajan and Shand, 1999). The potential of performance of any firm is set by the frontier formed as a locus of best

performing firms of the sample. Thus the technical efficiency of the firm can be defined as the ratio of firm's actual performance to its potential performance.
Hence, Efficiency = virtual output / virtual input
In other words,
Efficiency = Weighted sum of Outputs / Weighted sum of inputs

It is not sufficient for a firm to maximize its outputs for given set of inputs due to continuous change in technology, the effect of different set of inputs on different set of outputs due to ever-changing dynamics of business. The change of productivity over a period of time is more important a feature to be taken into consideration than a point change in a single period of time. Thus the productivity of a firm is the efficiency of the firm in optimally using the set of available technology, optimal conversion of given set of inputs for a given technological premise into optimal set of outputs.

3.6 Scale Efficiency and Returns to Scale

Empirical economics of efficient production quantifies Return to Scale (RTS) as scale elasticity, which is defined as the proportionate increase in outputs resulting from the proportionate increase in inputs. Increasing returns to scale (IRS) is exhibited by a production unit if a radial increase in input levels leads to a more than proportionate radial increase in output levels. Whereas decreasing returns to scale (DRS) is said to occur if a radial increase in input levels leads to a less than proportionate radial increase in output levels. The production unit demonstrates Constant returns to scale (CRS) if a radial increase/decrease in input levels leads to equal radial increase/decrease in output levels. Variable returns to scale (VRS) frontiers are those efficiency frontiers which allow returns to scale to vary according to the scale of inputs. The Variable returns to scale (VRS) frontiers produces a frontier which has increasing returns to scale at low input levels and decreasing returns to scale at high input levels. Thus, under VRS frontier an efficient DMU operating under IRS would gain in average productivity if the scale size is increased marginally. Based on the same idea an efficient DMU operating under DRS can increase its productivity by marginally decreasing its scale size. Thus the measure of scale efficiency gives valuable insights on the scale of operations of the efficient DMU and the subsequent alterations needed to be done to increase efficiency substantially.

3.7 The Hierarchical Cluster Method

The hierarchical cluster method over a fixed p time-period considers an ordered paired list$\{t_p, W_p; p=1, 2,\ldots,P\}$ Where t_p is different time periods and W_p is equal to x row matrices of the DEA efficiency score for x banks in each time period. In the present study, the t_p are the different years and x represents the 12 different banks. In each time-period t_p the hierarchical cluster method is applied to the W_p variable matrix. From each W_p matrix we obtain a D_j squared x-x distance matrix representing the dissimilarity or distance between each pair of individuals or objects based on the squared Euclidean distance. For a particular t_p the initial D_j matrix is a symmetric matrix and dij represents distance between the individuals *i* and *j*. From this Dj matrix we obtain the dendrogram treelike diagram based on the agglomerative algorithms. The final dendrogram describing the different cluster are formed based on the type of linkage method selected. There are mainly three types of linkages methods. The single linkage method, complete linkage method and average linkage methods, apart form the three still other methods like Ward's, the median or the centroid method are also used. Detailed analysis of the algorithm of the linkage methods is beyond the purview of this paper (refer Dillon et al. 1984 for numerical examples of these three algorithms). However the use of single linkage

and average linkage method leads to most consistent results and hence considered in our study. The help of statistical package SPSS 10.0 was in use to transmit out the calculations.

3.8 Measurement of Variables

The selection of input and output for measurement of bank performance is one of the widely debated issues. No clear consensus is reached till date on the set of ideal inputs and outputs. Different approaches are used in measuring bank outputs but there are two widely accepted approaches. One is Production Approach and the other Intermediation Approach. Production approach is based on the work of Benston (1964) and Bell and Murphy (1968). Under production approach banking activity is described as the production of services to depositors and borrowers. The output is measured by the number and type of transactions or accounts (both deposit and loan) and inputs being the physical units of labor and capital. Whereas, Intermediation Approach considers financial institutions as the link primarily intermediating funds between savers and investors. The inputs considered are essentially financial capital (i.e., the deposits collected by local branches and the funds borrowed from financial markets and their interest cost), and volume of loans and investments outstanding are the outputs. As already discussed there is no set rule to decide the inputs and output and thus, it has been recommended by various writers that the choice of input and output is dependent on the researcher commensurate to his research (Sealey and Lindley, 1977). The present study is conducted adopting Intermediation Approach to specify outputs and inputs of the selected Indian commercial banks. Following (Bhattacharya A, C.A.K Lovell and P. Sahay, 1986-91) the two inputs considered are Interest Expenditure and Operating Expenditure whereas the outputs are measured by Deposit, Advances and Investments.

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4. Results

4.1 Efficiency Analysis for the block P1

During the block P1 (refer table no-1), more than 75% of the banks were 100% financially efficient. The banks exhibited more or less stable scale efficiency. AXIS and BOB need to marginally bring down their scale of operation whereas CANARAB needs to slightly increase their scale of operation to become 100% technically efficient.OBC during the period has exhibited least scale efficiency (0.87) implying ineffective utilization of its scale of operation. Other banks were not 100% efficient but can be considered as par with the 100% efficient banks with their efficiency score ranging from 96.4% to 97.6%. So it can be safely concluded that majority of the banks were operating with almost 100% technical efficiency

Table 1. Technical efficiency Score (CRS and VRS) of the DMU along with the Scale efficiency and Inefficiency Score

Name of the DMU	TE(CRS)	TE(VRS)	Scale Efficiency	Scale In-efficiency
SBI	95.3	100	0.953	4.7
AXIS	100	100	1	0
ICICI	72	76.3	0.9436435	4.3
BOB	100	100	1	0
IDBI	100	100	1	0

Table 1. (Continued)

Name of the DMU	TE(CRS)	TE(VRS)	Scale Efficiency	Scale In-efficiency
BOI	100	100	1	0
HDFC	100	100	1	0
PNB	100	100	1	0
OBC	82	100	0.82	18
CANARAB	79.6	79.6	1	0
KMB	88.4	100	0.884	11.6
UB	89.9	99.9	0.8998999	10

Table 1a. The scope of improvement of the inefficient DMU according to their inputs and outputs

Name of the DMU	Interest Expenditure(-)	Operating Expenditure(-)	Deposits(+)	Advances(+)	Investments(+)
SBI	NA	NA	NA	NA	NA
AXIS	8.83	8.83	0	10.3	1.07
ICICI	3.51	3.51	34.19	0	0
BOB	2.58	2.58	0	3.01	7.66
IDBI	NA	NA	NA	NA	NA
BOI	NA	NA	NA	NA	NA
HDFC	NA	NA	NA	NA	NA
PNB	NA	NA	NA	NA	NA
OBC	12.6	12.6	0	1.96	1.75
CANARAB	4.45	4.45	0	0	9.33
KMB	NA	NA	NA	NA	NA
UB	NA	NA	NA	NA	NA

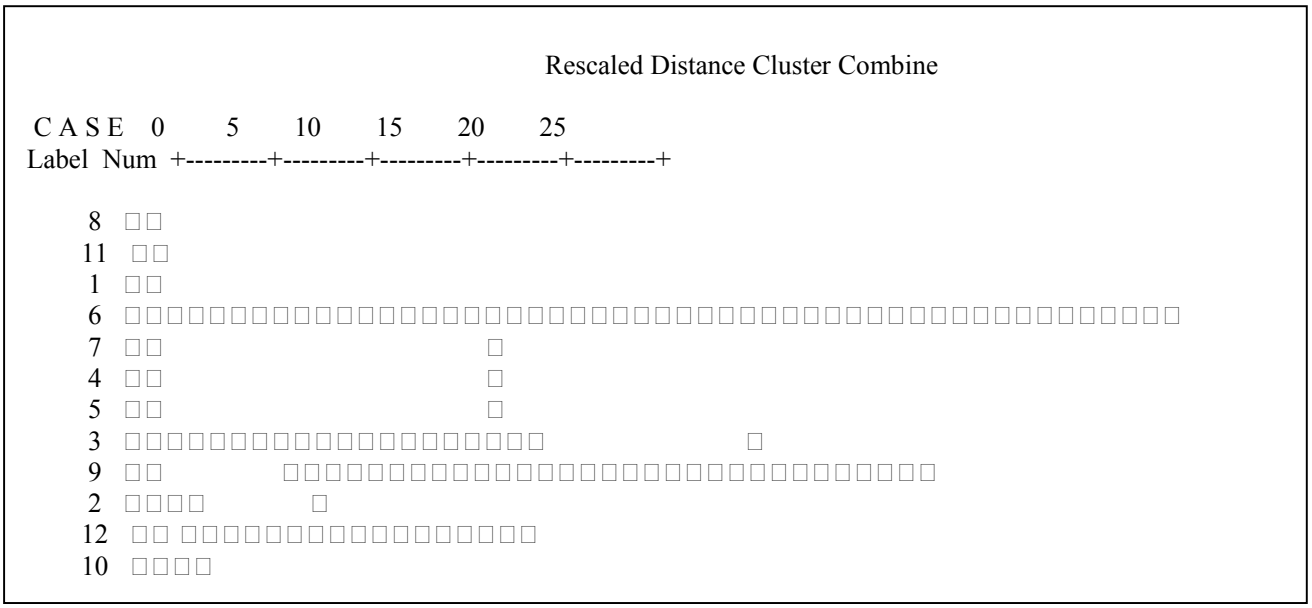
Amongst the inefficient banks, BOB, ICICI and CANARAB required a marginal reduction in their operating and interest expenditure to become full technically efficient, while OBC required the maximum reduction (12.6%) in the inputs amongst the inefficient banks. All the banks were successful in managing its deposits but ICICI failed miserably. The growth in deposit required an increase of 34.19% in order to make it 100% efficient. Although Investments were not efficiently managed by the inefficient banks requiring a growth of about 1.75 %(OBC) to 9.33(CANARAB), it was exceptionally managed well by ICICI requiring a nil growth rate. The management of advances portfolio was at par for all the banks, it was AXIS which required a growth of 10.3% in its advance portfolio to make it 100% technically efficient.

4.2 Efficiency Analysis for the block P2

Under CRS measurement of Technical efficiency little less than 60% of the banks were 100 % technically efficient during the block P2. Nearly 80% of the banks were 100% technically efficient when VRS measurement was considered. Thus it implies that financial crisis has affected the efficiency of the banks

but the banks were more effective to leverage upon the scale of operations to nullify the effect of financial meltdown. Like the previous years few banks managed to reach 100% technical efficiency by leveraging upon their scale of operation. ICIC, CANARAB and UB can become 100% efficient if they reduce their scale of operation slightly. OBC, KMB and UB were not much scale efficient with the scale efficiency score ranging from 0.82 to 0.89. The other banks were more or less 100 percent scale efficient.

Exhibit 4. Dendrogram using Average Linkage (Between Groups) for the block P4



Cluster analysis of the banks based on their technical efficiency score for all the four periods gives at most five groups and at least four. Group-I has the maximum number of banks under its fold (Refer table no-6). The banks comprising the group are not fixed amongst the four study periods. Few banks leave and join the group giving a hint of reorientation. IDBI, BOI and HDFC have exhibited 100% technical efficiency on all the periods and hence can be justified to fall in the same group. However PNB is included in the same group along with these banks when clusters are being formed. This relationship supports the fact that some synergistic relationship is ought to be playing between IDBI, HDFC, BOI and PNB.

5. Conclusion

Technical efficiency reflects the ability of the firm to manage its inputs by minimizing its use in order to effectively maximize the production of outputs. The Indian banking industry has been able to perform the task of efficient management of resources with considerable maturity and dynamism. The global financial crisis failed to have any impact on the technical efficiency of the Indian banking sector, although few banks were affected marginally. The efficient management of investments by all the banks during all the periods played a pivotal role in providing the banking sector its strength to face the financial crisis. It can be safely concluded that Indian banks are intrinsically efficient in managing its resources. Also the synergistic effect of the banks helped other banks in the industry to nullify the devastating effect of financial crisis. No major shift in cluster formation pre and post financial crisis is observed thus signifying the fact banks maintained stability and robustness undeterred by the global meltdown. However few issues regarding scale of operation remains to be a matter of concern. It is quite evident from the study that although banks are intrinsically efficient, scale of operation of the banks can act to be the 'Achilles heel' in near future.

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Appendix 1

Name of the DMU
SBI-State Bank of India
AXIS-Axis Bank Limited
ICICI-ICICI Bank Limited
BOB- Bank of Baroda
IDBI-IDBI Bank Limited
BOI-Bank of India
HDFC-HDFC Bank Limited
PNB-Punjab National Bank
CANARAB-Canara Bank
KMB-Kotak Mahindra Bank
UB-Union Bank