International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2014): 5.611

A Comparative Approach of DEA – AHP for Performance Measurement of Indian Banks

B. K. Gayval[1], V. H. Bajaj[2]

[1, 2]Dr. Babasaheb Ambedkar Marathwada University, Department of Statistics, Aurangabad-431004(MS), India

Abstract: ***Data envelopment analysis (DEA) is a methodology for measuring the relative efficiencies of a set of decision making units (DMUs) that use multiple inputs to produce multiple outputs. The main purpose of the study is to provide decision support for decision makers about the performance of banks by using multi criteria decision making techniques. In this paper, we investigate the efficiency of Nationalised Indian banks using Data Envelopment Analysis and Analytic Hierarchy Process (AHP) approach. In this study, we apply the DEA and AHP model for measuring the efficiency scores of Indian banks. This technique eliminates the ranking inefficiency of DEA and able to rank all Decision Making Units (DMUs) under consideration to measures the performance of Indians Banks to illustrate the approach.***

Keywords: Operations Research, Data Envelopment Analysis, Analytic Hierarchy Process, Indian Banks.

1. Introduction

The changing economic conditions have challenged many organizations to search for more efficient and effective ways to manage their business operations. Only an efficient banking system can contribute towards the formation of capital and implementation of monetary policy of a country. Indian banking industry has become an important tool to facilitate the development of the Indian economy. The Indian banking sector went through structural changes since its independence keeping in view its financial linkages with the rest of the economy and to meet the social and economic objectives of development (Kumbhakar and Sarkar, 2005). Facing major economic crisis, the Reserve bank of India (RBI) launched major banking sector reforms in 1991 aimed at creating a more profitable, efficient and sound banking system, based on the recommendations of the first Narasimham committee on financial sector reforms. The purpose of this paper is to propose a methodology based on Data Envelopment Analysis (DEA) and Analytical Hierarchy Process (AHP) that addresses to this issue of efficiency using Indian banks data (source RBI Website).

The application of quantitative techniques in the area of finance became very popular and especially, assessing Bank performance with the use of advances in Operational Research. Using a recognized and valid measure of efficiency is critical for managers seeking to increase the effectiveness of their organizations. Over the past two decades, data envelopment analysis (DEA) has become a popular methodology for evaluating the relative efficiencies of decision making units (DMUs). DEA is an approach to estimate the production function of organizations and organizational units and enables the assessment of their efficiency. DEA and AHP are methods that have been extensively used to evaluate and rank multi-objective decision alternatives.

2. Literature Review

In 1978, Charnes, Cooper and Rhodes (CCR) described a mathematical programming formulation for the empirical evaluation of relative efficiency of a Decision Making Unit (DMU) on the basis of the observed quantities of inputs and outputs for a group of similar referent DMUs. Banker (1980) and Banker, Charnes and Cooper (1984) (BCC) provided a formal link between DEA and estimation of efficient production frontiers via constructs employed in production economics. Sathye (2003) used DEA to study the relative efficiency of Indian banks in the late 1990‟s with that of banks operating in other countries. He found that the public sector banks have a higher mean efficiency score as compared to the private sector banks in India, but found mixed results when comparing public sector banks and foreign commercial banks in India.

Kumbhakar and Sarkar (2004) estimated the cost efficiency of public and private sector banks in India by using the stochastic cost frontier model with specification of translog cost function. Seiford and Zhu (1999) examined the performance of the top 55 US banks using a two-stage DEA approach. Results indicated that relatively large banks exhibit better performance on profitability, whereas smaller banks tend to perform better with respect to marketability. Drake and Howcroft (2002) assessed the relative efficiency of UK clearing bank branches using DEA method. This paper utilized the basic efficiency indices and extended the analysis by examining the relationship between size and efficiency. Many of these studies find that state-owned banks are more efficient than private and foreign banks (Bhattacharyya and Pal, 2013; Sharma et al., 2012 and Debasish (2006) find that foreign banks are actually the most efficient. Objective of the study is to measure and compare the performance of Public and Private sector banks of India using input oriented VRS model of Data Envelopment Analysis. In recent years, Azadeh et al. (2008) integrated DEA and AHP with computer simulation for railway system improvement and optimization; they considered both quantitative and qualitative variables for efficiency assessment and performance optimization by integration simulation. Korpela et al. (2007) proposed an approach for selecting the warehouse operator network by combining DEA and AHP. DEAHP (data envelopment analytic hierarchy process) is a new model that has been developed by Ramanathan (2006b); it is a hybrid methodology of DEA and AHP, used to prove that DEA correctly estimates the true weight when applied to a consistent matrix formed using a known set of weights.

3. Methodology

3.1 Data Envelopment Analysis

Data Envelopment Analysis is a linear programming procedure for a frontier analysis of inputs and outputs. The basic DEA model for „n" DMUs with „m" inputs and „s" outputs proposed by CCR, the relative efficiency score of pth DMUs is given by

$$MaxZ_p = \frac{\sum_{k=1}^{s} V_k Y_{kp}}{\sum_{j=1}^{m} U_j X_{jp}}$$

$$s.t. \frac{\sum_{k=1}^{s} V_k Y_{ki}}{\sum_{j=1}^{m} U_j X_{ji}} \le 1 \forall i \qquad \backslash \qquad (1)$$

$$V_k, U_j \ge 0 \forall k, j$$

Where k = 1 to s (number of outputs); j = 1 to m (number of inputs); i = 1 to n (number of DMUs); Y_{ki} = amount of output k produced by DMU i; X_{ji} = amount of input j utilized by DMU i; V_k = weight given to output k and U_j = weight given to input j.

The fractional programme shown in Equation (1) can be reduced to LPP as follows:

$$\text{MaxZ}_P = \sum_{k=1}^{s} V_k Y_{kp}$$

$$\text{s.t.} \sum_{k=1}^{s} U_J X_{JP} = 1$$

$$\sum_{k=1}^{s} V_k Y_{ki} - \sum_{k=1}^{s} U_J X_{Ji} \le 0 \forall i \qquad (2)$$

$$V_k, U_J \ge 0 \forall k, j$$

This model is called CCR output oriented maximization DEA model. The efficiency score of „n" DMUs is obtained by running the above LPP „n" times.

3.2 DEA -AHP Approach

AHP is a mathematically-based multi-criteria decision making (MCDM) tool introduced by Saaty [13] in 1970s. The AHP enables decision makers to structure a complex problem in the form of a simple hierarchy and to evaluate a large number of quantitative and qualitative factors in a systematic manner under multiple conflicting criteria. The AHP makes use of pairwise comparison matrices, hierarchical structures, and ratio scaling to apply weights to attributes.

Suppose there are n decision units and each unit has m inputs and s outputs i.e. X_{ij} - i^{th} input of j^{th} DMU & Y_{ij} - i^{th} output of j^{th} DMU. Then the DEA method is used to calculate the relative efficiency of each pair of DMUs (without considering the other DMUs). E_{AA} and E_{BA} are the relative efficiency of DMU_A and DMU_B.

$$E_{AA} = \max \sum_{r=1}^{s} U_r Y_{rA} \qquad (3)$$

$$\begin{cases} \sum_{i=1}^{m} v_i x_{iA} = 1 \\ \sum_{r=1}^{m} u_r y_{rA} \le 1 \\ \sum_{r=1}^{m} u_r y_r - \sum_{i=1}^{m} v_i x_{iB} \le 0 \\ u_r \ge 0, r = 1,2, \ldots, s \\ v_i \ge 0, i = 1,2, \ldots, m \end{cases}$$

$$E_{BA} = \max \sum_{r=1}^{s} U_r Y_{rB} \qquad (4)$$

$$\begin{cases} \sum_{i=1}^{m} v_i x_{iB} = 1 \\ \sum_{r=1}^{m} u_r y_{rB} \le 1 \\ \sum_{r=1}^{m} u_r y_{rA} - E_{AA} \sum_{r=1}^{m} v_i x_{IA} \le 0 \\ u_r \ge 0, r = 1,2, \ldots, s \\ v_i \ge 0, i = 1,2, \ldots, m \end{cases}$$

Similarly we can be calculated for E_{BB} and E_{AB}.
Then the relative efficiency ratio of DMU_A and DMU_B

$$a_{AB} = \frac{E_{AA} + E_{AB}}{E_{BB} + E_{BA}} \qquad (5)$$

Generally, there is j row and k column element a_{jk} in the AHP judging matrices:

$$a_{jk} = \frac{E_{jj} + E_{jk}}{E_{kk} + E_{kj}} \qquad (6)$$

And $a_{jj} = 1, a_{kj} = \frac{1}{a_{jk}}$

We have constructed pairwise comparison matrix from above equation, then judging metric find from above equation 6. After calculation of judging metric, we can be obtained characteristics vector i.e. $\omega = (W1, W2, \ldots Wn)^T$, where W_j is the relative importance level of the number J DMU. So the ranking of all DMU will be equal to as relative importance level.

4. Problem Formulation & Data Source

There is a mathematical approach to DEA that can be adopted which is illustrated using Linear Programming technique. In this paper, we have analyzed efficiency of Indian commercial Banks using DEA and DEA-AHP approach. In this paper, we have taking 12 Indian Banks data during year of 2011-12. Data has been collected from RBI website for evaluation purpose.

5. Result & Discussion

Firstly, we have calculated all DMU"s rank using CCR technique of DEA shown in table 2. The relative efficiency of each pair of DMUs has been calculated by using equation 3 & 4 to construct comparison matrix. We have computed the DEA-AHP judgment matrix using equation 5. Further we have found normalized matrix then calculate characteristic vector shown in Coolum 4 at table 2. This DEA-AHP result has used for the ranking of all the DMUs.

Table 1: Data table for financial year 2011-12

DMU's	Input		Output	
	Interest expended	Operating expenses	Investments	Interest income
Bank of Baroda	193567	51587	832094	296737
Bank of India	201672	49407	867536	284807
Canara Bank	231613	46737	1020574	308506
Oriental Bank of Commerce	115991	23155	521013	158149
Punjab National Bank	230617	70028	1227030	364761
Union Bank of India	142354	39875	623636	210285
IDBI Bank Ltd.	188251	26075	831754	233699
State Bank of India	632304	260690	3121976	1065215
Axis Bank	139769	60071	931921	219946
HDFC Bank	149896	92776	974829	278742
ICICI Bank	75028	228085	1595600	335427
Kotak Mahindra Bank	36677	18348	215668	61802
Note-Amount in Million				

Table 2: Ranking of Banks using DEA & DEA-AHP Model

DMUs	DEA Score		DEA-AHP Score	
	Score	Rank	Score	Rank
State Bank of India	1.000	1	0.130	1
ICICI Bank	1.000	1	0.124	3
IDBI	1.000	1	0.127	2
Canara Bank	0.990	2	0.122	4
Punjab National Bank	0.987	3	0.121	5
Bank of India	0.974	4	0.118	6
Axis Bank	0.963	5	0.116	7
HDFC Bank	0.960	6	0.115	8
Bank of Baroda	0.940	7	0.113	9
Union Bank of India	0.934	8	0.109	10
Oriental Bank of Commmerce	0.900	9	0.106	11
Kotak Mahindra Bank	0.880	10	0.102	12

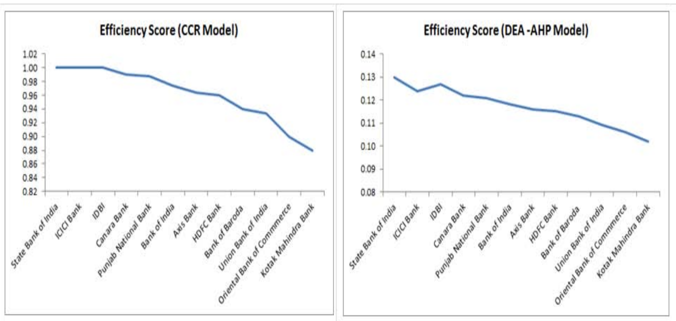

Figure 1: Bank wise performance trend using DEA & DEA-AHP model

6. Conclusion

A sample of 12 Indian commercial banks has been analyzed for effectiveness using DEA & DEA-AHP approach. The analysis provides the precise corrective figure for every output and input in order to improve their efficiency of an inefficient bank. We have investigated the performance of Indian banks by using CCR based DEA model (Table 2). Results indicate that, State Bank of India, ICICI Bank and IDBI has more efficient and its ranking score found as 1 for all three banks. After applying DEA-AHP Model to further analyze who has first rank, then the State Bank of India is most efficient compare to ICICI & IDBI Banks (result shown in table 2). Also we have found that the IDBI bank has better then ICICI banks using DEA-AHP approach. This study provides scope for further research using larger sample size and panel data with different sets of input and outputs using MCDA criteria to test the robustness of the results.

References

[1] Charnes, A., Cooper, W.W. and Rhodes, E. (1978), "Measuring the efficiency of decision making units", European Journal of Operations Research, 2: 429-444.

[2] Bhattacharyya and S. Pal. (2013). Financial reforms and technical efficiency in Indian commercial banking: A generalized stochastic frontier analysis. Review of Financial Economics, 22(3):109–117.

[3] S.Sharma, D. Raina, and S. Singh. (2012) Measurement of technical efficiency and its sources: An experience of Indian banking sector. Journal of Economics and Management, 6: 35–57.

[4] G.D. Ferrier and C.A.K. Lovell. (1990) Measuring cost efficiency in banking: Econometric and linear programming evidence. Journal of Econometrics, 46:229–245, 1990.

[5] Cooper, W.W., Seiford, L.M. and Tone, K. (2000) Data envelopment Analysis, Boston: Kluwer.

[6] Banker, R., Charnes, A., & Cooper, W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science, 30, 1078–1092.

[7] Wang, N. S., Yi, R. H., & Wang, W. (2008). Evaluating the performances of decision making units based on interval efficiencies. Journal of Computational and Applied Mathematics, 216, 328–343.

[8] Seiford, L., & Zhu, J. (1999). Profitability and marketability of the top 55 US commercial banks. Management Science, 45, 1270–1288.

[9] Sengupta, J. (1995). Dynamics of data envelopment analysis: Theory of systems efficiency. Boston, MA: Kluwer Academic Publishers.

[10] Satye. M, (2003). Efficiency of Banks in developing Economy. The case of India. European Journal of Operational Research. 148(3). 662-671.

[11] Sun, S., & Lu, W. (2005). Evaluating the performance of the Taiwanese hotel industry using a weight slacks-based measure. Asia-Pacific Journal of Operational Research, 22, 487–512.

[12] Ramanathan, R., (2006b) Data envelopment analysis for weight derivation and aggregation in the analytic

hierarchy process. Computer and Operation Research 33, 1289–1307.

[13] Saaty, T.L., (1987) Rank generation, preservation and reversal in the analytic hierarchy process. Decision Sciences 18, 157–177.

[14] Saaty, T.L., (1980) The Analytic Hierarchy Process: Planning, Priority Setting and Resource Allocation. McGraw-Hill, New York.

[15] Vaidya, O.S., Kumar, S., (2006) Analytic hierarchy process: An overview of applications. European Journal of Operational Research 169, 1–29.

[16] M. Lin, Y. Lee, and T. Ho, (2011) "Applying integrated DEA-AHP to evaluate the economic performance of local governments in China," European Journal of Operational Research, vol. 209, pp. 129-140.

[17] Korpela, J., Lehmusvaara, A., Nisonen, J., (2007). Warehouse operator selection by combining AHP and DEA methodologies. International Journal of Production Economics 108 (1–2), 135–142.

[18] Azadeh, A., Ghaderi, S.F., Izadbakhsh, H., (2008). Integration of DEA and AHP with computer simulation for railway system improvement and optimization. Applied Mathematics and Computation 195 (2), 775–785.

[19] Ying Ming Wang, Kwai-Sang Chin,Gary Ka Kwai Poon, (2008). A data envelopment analysis method with assurance region for weight generation in the analytical hierarchy process, Decision Support Systems 45, 913-92.

[20] Sinuauny-Stern, Zilla., Mehrez, Abraham., Hadad, Yossi., (2000).An AHP/DEA Methodology for Ranking Decision Making Unit.