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A study on operational efficiency of public and private sector banks: A DEA Approach

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ABSTRACT

Financial system of a country plays a very crucial role in functioning of economy by allowing transfer of resources from depositors to investors. Efficient intermediation of funds from savers to users enables the productive application of available resources. The greater the efficiency of the financial system in such resource generation and allocation, the higher is its likely contribution to economic growth. In today's economic scenario, finance forms one of the foundation of economic activity of human beings. Banking institutions bridge the gap between those who have money or savings and those who need it. The study employs non-parametric method, the DEA model to construct a best practice frontier from the observed data and to measure efficiency relative to the constructed frontier. The efficiency of bank is measured in terms of how efficiently they are able to utilize their inputs given their outputs. The study reveals that the operating efficiency of public sector banks and private sector banks in India. The Indian banking sector have more developments in last two decades, still they have to improve their technical efficiency.

1. Introduction

Financial sector is the backbone of every country. Financial system is perceived to be the brain of the economy. Financial system of a country plays a very crucial role in functioning of economy by allowing transfer of resources from depositors to investors. Efficient intermediation of funds from savers to users enables the productive application of available resources. The greater the efficiency of the financial system in such resource generation and allocation, the higher is its likely contribution to economic growth. In today's economic scenario, finance forms one of the basic foundation of economic activity for human beings. Financial institutions bridge the gap between those who have money or savings and those who need it. Finance is required for the growth, expansion, progress and survival. In every country financial markets exists to have proper control over the financial activities. Process of economic development is facilitated through capacity creation and income generation by financial institutions.

As per **Halbury's** law "banker can be an individual, partnership or corporation, whose sole or predominating business is banking, that is the receipt of money on current or deposit account, and the payment of cheques drawn by and the collection of cheques paid in by the customer.

2. Review of Literature

Amit Kumar Dwivedi and D. Kumara Charyulu(2011) seeks to determine the impact of various market and regulatory initiatives on efficiency improvements of Indian banks. Efficiency of firm is measured in terms of its relative performance. Data Envelopment Analysis (DEA) has been used to identify banks that are on the output frontier. The study is confined only to the Constant-Return-to-Scale (CRS) assumption of decision making units. It was found from the results that national banks, new private banks and foreign banks have showed high efficiency over a period time than remaining banks.

Singh, Ravi Inder (2016) examined the Efficiency and Profitability of Public and Private Sector Banks in India using Data Envelopment Analysis. The study includes analysis of slacks which remain to be explored for getting a clear picture about the causes of inefficiency. The results revealed that private sector banks are relatively more efficient compared to public sector banks. It was found that State Bank of Hyderabad, Bank of Maharashtra, Central Bank of India, United Bank of India, Dhanalaxmi Bank and ING Vysya could not achieve 100 percent efficiency even in a single year, whereas the Federal Bank, HDFC Bank, Kotak Mahindra Bank, Nainital Bank and Yes Bank Ltd., all private sector banks, achieved full efficiency in all the ten years.

Soheila Seyedboveir et.al (2017) examined Cost Efficiency Measurement in Data Envelopment Analysis with Dynamic Network Structures. The classical DEA models ignore operations of individual processes within a system; moreover, they compute efficiency at the same time. Therefore, we suggest a relational model to estimate cost efficiency in static network structures. Also, we incorporate the dynamic effect in network structures. The proposed models here evaluate the overall efficiency over the whole periods and indicate it as a weighted average of period efficiencies. The main advantage revealed in this study is recognition of: which divisions at what periods caused the inefficiency of the system, the internal activities of the system over time, considered; moreover, the results obtained here is applicable in, improving the performance of the system.

Lina Novickytė and Jolanta Droždz (2018) explained the efficiency of the banks in Lithuania by employing the DEA method and evaluate bank performance in a low interest rate environment. The efficiency scores were calculated with a non-parametric frontier input-oriented DEA technique with the variable returns to scale (VRS) and the constant returns to scale (CRS) assumptions. Five alternative models with different input-output combinations were developed, based on production, profitability and intermediation dimensions. The main bank profitability measure the return on assets (ROA) ratio was employed to validate the results obtained using the DEA method. The Lithuanian bank's efficiency analysis based on the VRS assumption showed that better results are demonstrated by the local banks. The technical efficiency analysis based on the CRS assumption showed other results: the banks owned by the Nordic parent group and the branches have higher pure efficiency than local banks and have success at working at the right scale. Based on this, it stated that during the period 2012–2016 the larger Lithuanian banks (subsidiaries) applied a more appropriate business model than smaller (local) banks operating in Lithuania. Additionally, this research contributes to the scholarly literature in the field of determinants of bank business performance in concentrated markets dominated by foreign banks and, in particular, from one region.

3. Objective

1. To evaluate the financial performance of public sector and private sector banks using DEA model.
2. To give suggestions for the financial improvement of banks in India.

4. Research Methodology

The present study is a descriptive based analytical research design. Twenty seven public sector banks and twenty two private sector banks are selected for the study. The study had used the secondary data published by the Reserve Bank of India for the period 2008-09 to 2017-2018. DEA Model and Correlation have been selected to assess the performance of banks. Ten years average has been calculated with the help of arithmetic mean.

5. Analysis and Discussion

DEA Analysis

DEA is a linear programming technique initially developed by Charnes, Cooper and Rhodes (1978) to evaluate the efficiency of public sector non-profit organizations, based on earlier work initiated by Farell (1957). It was later extended by Banker et al. (1984). Sherman and Gold (1985) were the first to apply DEA to banking. DEA calculates the relative efficiency scores of various Decision-Making Units (DMUs) in the particular sample. The ability of the DEA to identify possible peers or role models as well as simple efficiency scores gives it an edge over other methods. As an efficient frontier technique, DEA identifies the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient, rather than trying to associate a DMU's performance with statistical averages that may not be applicable to that DMU.

The study employs non-parametric method, the DEA model to construct a best practice frontier from the observed data and to measure efficiency relative to the constructed frontier. The output efficiency reflects the extent to which the output can be raised through improved performance without additional resources and input efficiency reflect the extent to which the input levels of the unit concerned can be lowered through improved performance without output reduction (Thanassoulis, 2001). The efficiency of bank is measured in terms of how efficiently they are able to utilize their inputs given their outputs. Evaluation of technical efficiency of the banks and monitoring of their financial positions is of critical importance to investors and bank managers as the efficiency scores are informative signals of management quality (Barr et al, 1994; Wheelock and Wilson, 1999). The following analyses are carried for capturing the efficiency of banking sector.

Technical efficiency, TE = CE/AE or PTE × SE.
Pure technical efficiency, PTE = TE/SE.
Scale efficiency, SE = TE/PTE.

Constant Returns to Scale (CRS or CCR)

Charnes, Cooper and Rhodes (1978) proposed a model which had input orientation and assumed constant return to scale (CRS). Assume that there are *n* DMUs consuming varying amounts of *k* different inputs to produce m different outputs. Specifically, DMU_i are represented by x_i and y_i respectively. The K×N input matrix, X and M×N output matrix Y represent the data of N firms. The purpose of DEA was to construct the frontier that the observed data lie on or below the production frontier. For each DMU a measured ratio of all outputs (y) over all inputs (x), such as u'y/v'x, where u is output weight and v is input weight. To select optimal weights, the mathematical programming problem:

$$\text{Max}_{uv}\ (u'y_i/v'x_i)$$

$$\text{s.t}\ \ u'yj/v'xj \leq 1 \qquad j = 1,2,\ldots.N$$

$$u,v \geq 0 \qquad (1)$$

The finding values for u and v, such that the efficiency measure of the i^{th} DMU is maximised, subject to the constraint that all efficiency measures must be less than or equal to one. One problem with this particular ratio formulation is that it has an infinite number of solutions. To avoid this, an equivalent envelopment form of this problem is estimated, *i.e.*

$$\text{Min}\ \theta,\lambda\theta$$
$$\text{s.t}\ -yi + y\lambda \geq 0$$
$$\theta xi - X\lambda \geq 0$$
$$\lambda \geq 0 \qquad (2)$$

The value of θ obtained will be the efficiency score of i^{th} DMU. It will satisfy θ≤1, with a value of 1 indicating the point on the frontier and technical efficient DMU.

Super Efficiency

Andersen and Petersen's model for estimating *super-efficiency* score for DMU *k* (denoted by $TE^{k,\,super}$

$$\text{Min } \theta \quad {}_{TE}\, k, \text{super}_{=\theta} \quad \lambda, s^{-}, s^{+} \quad - \varepsilon[\sum s^{-} + \sum s^{+}]$$

Subject to

$$\lambda y - s^{+} = y \qquad r = 1, 2 \ldots s$$

$$\lambda x + s^{-} = \theta x \qquad r = 1, 2 \ldots m$$

$$s^{-}, s^{+} \geq 0$$

$$\Lambda j \neq k \geq 0 \qquad j = 1, 2 \ldots n.$$

The difference between Super-efficiency model and standard efficiency model is that in super models the DMU_0 (the DMU evaluated) is eliminated from the reference set (indicated by j≠0 in the LP). The Super-efficiency score can be greater than 1.

Variable Returns Scale (VRS or BBC)

The CRS assumption is appropriate only when the firm is operating under constant returns to scale. Due to certain constraint the firm may be unable to operate at optimal scale. BCC (Banker et al., 1984) made an extension of CRS to VRS situations. This model is modified by convexity constraint N1'λ = 1 to (2) hence

$$\text{Min}_{\theta,\ \lambda} \ \theta$$

$$\text{s.t} \ -y_i + y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$N1'\lambda = 1$$

$$\lambda \geq 0 \qquad (3)$$

N1 is N ×1 vector of one. This convex hull of intersecting will tighten the data points than in CRS and provide the efficiency score greater than or equal to the value obtained from CRS model.

Scale Efficiency

The score obtained from CRS model and VRS model are calculated and their difference are calculated as scale efficiency of that DMU. This can be expressed by substituting N1'λ = 1 restriction with N1'λ ≤ 1 in *(3)*

$$\text{Min}_{\theta,\ \lambda} \ \theta$$

$$\text{s.t} \ -y_i + y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$N1'\lambda \leq 1$$

$$\lambda \geq 0 \qquad (4)$$

The scale efficiency refers to the firm's ability to work at the optimal scale since $TE_{CRS} = TE_{VRS} \times SE$. This can be expressed as $SE = TE_{CRS} / TE_{VRS}$. Corresponding to these efficiency measures, the measures of inefficiency can be obtained as $(TE_i^{-1} - 1)$, $(PTE_i^{-1} - 1)$ and $(SE_i^{-1} - 1)$, respectively (Isik and Hassan, 2002).

Correlation Coefficient

Karl Pearson's coefficient of Correlation is most widely used method of measuring the degree of relationship between two variables. It is also known as Pearson's coefficient of correlation. It is donated by symbol r. It is quantitative method of measuring correlation. The value of r lies between ± 1. Positive values of r indicate positive correlation between the two variables whereas negative value of r indicates negative correlation. When r =+1, it indicate perfect positive correlation and when r = -1, it indicates perfect negative correlation. When r =0, it indicates no correlation. Karl Pearson's coefficient of correlation can be worked out as follows:

$$\mathbf{r = \Sigma(X-)\,(Y-)/n\ \sigma_x \sigma_y\ XY}$$

Where,

Σ(X-)(Y-) = summation of product of deviations of values of variable X and Y from their respective AMs XY

n = number of pairs of observations of X and Y

σ_x = standard deviation of X

σ_y = standard deviation of Y

To test the significance of association between variable, the study has applied variables are,X1-Deposits,X2-Advance,X3-Investments,X4-Total Assets.

6. DEA Model

Constant Returns to Scale (CRS or CCR):

Charnes, Cooper and Rhodes (1978) proposed a model which had input orientation and assumed constant return to scale (CRS). The annual technical efficiency scores is presented in Table-1.

Table -1
Annual Technical Efficiency Scores Bank –Wise (CRS Model)

YEAR	PUBLIC SECTOR BANKS	PRIVATE SECTOR BANKS
2008-09	1.000	0.931
2009-10	1.000	1.000
2010-11	1.000	1.000
2011-12	0.994	1.000
2012-13	1.000	1.000
2013-14	0.980	0.983
2014-15	0.966	0.978
2015-16	0.920	1.000
2016-17	0.946	0.993
2017-18	1.000	1.000
Mean	**0.975**	**0.980**

Sources: RBI statistical report

In the study period public sector banks had the efficiency score less than one during 2011-12 (0.994), 2013-14 (0.980), 2014-15 (0.966), 2015-16 (0.920), and 2016-17 (0.946). The efficiency score during the year 2008-09 to 2010 to 11, 2012-13 and 2017-18 was equal to one. There was a fluctuation over the study period. Since 2008, the efficiency was more for public sector banks and was found to have a higher efficiency since 2011. The private sector banks also have fluctuations over the study period. During the period 2008-09 (0.931), 2013-14 (0.983), 2014-15 (0.978) and 2016-17 (0.993), the values are less than one. The efficiency score during the year 2009-10 to 2012-13, 2015-16 and 2017-18 will be equal to one. The overall result showed that the Indian commercial banks have fluctuations over the study period. The mean value of public sector banks was 0.975 and the private sector bank was 0.980.

Pure technical efficiency

Pure technical efficiency is the technical efficiency attained under the variable returns to scale (VRS), i.e., TE is devoid of scale efficiency effects. According to Bhattacharya et al. (1997), it is the ability to transform multiple resources into multiple financial services. The efficiency has been calculated using variable returns to scale (VRS) input oriented model of the DEA methodology to measure efficiency as management's success in controlling costs and generating revenues. The empirical evidence suggests that the largest input inefficiencies are not the product of poor regulation, but direct result from an under-utilization of factor inputs by bank management. Thus, technical inefficiency is also called 'managerial inefficiency' in the literature because it is the one aspect of efficiency over which the management has direct control. The pure technical efficiencies of different banking units under VRS models of DEA approach are presented in table-2. Pure technical inefficiency (i.e., wastage of inputs in producing a certain output bundle) emanates from the inefficient functioning of the management in utilizing inputs in production process.

Table -2
Annual Pure Technical Efficiency Scores Bank –Wise (VRS Model)

YEAR	PUBLIC SECTOR BANKS	PRIVATE SECTOR BANKS
2008-09	1.000	0.963
2009-10	1.000	1.000
2010-11	1.000	1.000
2011-12	0.997	1.000
2012-13	1.000	1.000
2013-14	1.000	0.996
2014-15	1.000	0.989
2015-16	1.000	1.000
2016-17	1.000	1.000
2017-18	1.000	1.000
Mean	**1.000**	**0.992**

Sources: RBI statistical report

In the study period the pure technical efficiency was less than one for public sector banks during 2011-12 (0.997) and for private sector banks during 2008-09 (0.963), 2013-14(0.996), 2014-15(0.989). The Indian public sector banks are more efficient during the study period. There was a marginal fall in the efficiency score and regained its position and had steady efficiency in public sector banks, between 2007-08 to 2010-11, and 2013-2018 the efficiency score will be one, and private

sector banks had the steady growth from 2009-10 to 2012-13 and 2015-16 to 2017-18 the efficiency score will be one. The mean value for public sector banks was (1.000) and for private sector banks (0.992).

Scale Efficiency

Scale efficiency, measures whether a bank has the right size, i.e., whether it produces where the long run average curve (LRAC) is minimum when constant returns to scale (CRS) is observed. The bank is said to have scale efficient, when it operates in the range of constant returns to scale and have scope efficiency when it operates in different diversified locations (Chen, 2001). Scale efficiency (SE) refers to a proportional reduction in input usage if the bank can attain the optimum production level. Scale inefficiency may be the result of either market or regulatory forces that make the optimal level of outputs unachievable since it involves the choice of an inefficient level.

Table -3
Annual Scale Efficiency Score by Banks

YEAR	PUBLIC SECTOR BANKS	PRIVATE SECTOR BANKS
2008-09	1.000	0.967
2009-10	1.000	1.000
2010-11	1.000	1.000
2011-12	0.997	1.000
2012-13	1.000	1.000
2013-14	0.980	0.988
2014-15	0.966	0.990
2015-16	0.920	1.000
2016-17	0.946	0.993
2017-18	1.000	1.000
Mean	**0.975**	**0.988**

Sources: RBI statistical report

Scale efficiency expresses the changes in the deviation between the VRS and CRS technologies denoted as scale efficiency. Scale efficiency in each period is calculated as the ratio of the distance function satisfying constant returns to scale to the distance function restricted to satisfy variable returns to scale. Scale efficiency measures whether a bank is providing the most cost-efficient level of outputs, i.e., whether a bank is operating at the optimal scale.

The table-3 represents the scale efficiency score by banks. In the study period public sector banks showed its optimum scale efficiency or benchmark performance during 2009, 2010, 2011, 2013 and 2018 The private sector banks showed its optimum scale performance during 2009-13, 2015-16 and 2017-18, throughout this period private sector banks had higher efficiency followed by public sector banks. Since then there was a reduction in the efficiency level across all banks and the gap of efficiency level between banks also declined. The mean value of scale performance of public sector banks was 0.975 and private sector bank was 0.988.

Correlation

Karl Pearson's coefficient of Correlation is used for measuring the degree of relationship between variables. The table- 4 explains the correlation co-efficient for private sector banks.

Table – 4
Correlation

private sector banks				
Variables	**Deposit**	**Advance**	**Investment**	**Total asset**
Deposit(x_1)	1	1.000**	.999**	.962**
Advance(x_2)	1.000**	1	.999**	.968**
Investment(x_3)	.999**	.999**	1	.966**
Total asset(x_4)	.962**	.968**	.966**	1
Public sector banks				
Variables	**Deposit**	**Advance**	**Investment**	**Total asset**
Deposit(x_1)	1	.965**	.964**	.858**
Advance(x_2)	.965**	1	1.000**	.957**
Investment(x_3)	.964**	1.000**	1	.957**
Total asset(x_4)	.858**	.957**	.957**	1

***. Correlation is significant at the 0.01 level (2-tailed).*

Karl Pearson's coefficient of Correlation used to measure the degree of relationship between two variables. The table-4 reveals that the correlation between the variables namely deposits, advances, investments and total assets showed its significance at 0.01 level. The table shows the positive and perfect correlation between the variables, because all the variables like deposit, advance, investment and total asset are correlated with each other within the values of ± 1. So it is positively correlated with the variables.

7. Conclusion

Due to radical changes in the banking sector in the recent years, the commercial banks all around the world have improved their supervision quality and techniques. In evaluating the functioning of the banks, many of the developed countries are now following Data Envelopment Approach for calculating the technical efficiency of banks. The study reveals that the operational efficiency of public sector banks and private sector banks in India. The Indian banking sector have more developments in the last two decades, still they have to improve their technical efficiency.

8. Suggestions

Banks should use more and more benchmarks in order to have a comparison with global players. Moreover, these benchmarks motivate the bankers to compete with their peers.

For an effective monitoring system, more statistical tools should be applied periodically(monthly).

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