Performance Measurement of Indian Banks using Data Envelopment Analysis

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Abstract—In the paper an attempt was made to study the performance of Indian Banks with the help of CAMEL rating system, taking eighteen banks (eight being Private Sector Banks and ten being Public Sector Banks) over the period of ten years from (2004 to 2013) and then finding out their efficiency of banks with the help of DEA in terms of gaining confidence from investors and ranking them accordingly. Our finding suggests that private sector banks are in advantage situation and thereby hinting at the possibility of further improvisation of most of the public sector banks. Private sector banks show marked consistency in their efficiency level during the period under study.

Index Terms—DEA, CAMEL rating, Indian banks.

I. INTRODUCTION

Banking Sector is considered a main driving force for industries in a particular economy, which tries to absorb shocks of varying magnitude in different time horizon.

The Indian banking system has witnessed a very long history where the Indian Central Bank, The Reserve Bank of India (RBI) came into operation from 1935 but only after independence RBI was given broad regulatory authority over commercial banks in India. Real development in Indian economy started only after nationalization since private banks was not lending much who need the most as many banks failed in different countries leading varying degree of crisis leading to the strangeling of economic growth for this reason CAMEL rating system serves as a barometer to gauge the financial and operational soundness of banks to mitigate such crisis in near future. This paper deals with the performance of Indian, Private and Public Sector banks using CAMEL rating and then finding out their value (financial soundness) translation in terms of gaining confidence from investors and ranking them accordingly with the help of Data Envelopment Analysis (DEA).

The efficiency measure within a group of companies can be carried out by three methods, namely ratio analysis, parametric method and non-parametric method. Ratio analysis indicates a simple relationship between two terms. The parametric method includes Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA) or Distribution Free Approach (DFA). And non-parametric method includes Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH). The main difference between parametric and non-parametric approach is the former measure economic efficiency (i.e. the level of input & output based on price or cost) but later measures technical efficiency (which involves a level of input or output).

II. LITERATURE REVIEW

[1] Rajiv Banker and et.al. (1986) compared econometric model of translog cost function and DEA in Hospital production. In their research it is evident that translog cost function follows constant return whereas the DEA suggest both increasing and decreasing returns to scale but in their results both models agrees that taking care of children are more resource intensive than devotion to adults or to elderly.

[2] Charnes. A., Cooper, W.W., Rhodes (1978) were first to introduce DEA. Initially efficiency measure was evaluated for not-for-profit entities. They developed objective determining weight similar to ordinary linear programming method and constructed scale measuring efficiency for each of participating unit later coined as Decision Making Units (DMU’s).

[3] Mishra, A. K., Harsha, G., Anand S. and Dhruva, N. R., (2012) measured the performance of 12 public & private sector banks over a period of twelve years for which CAMEL rating was used. In their study individual parameter of CAMEL were ranked for Indian Banks and final composite rank was computed taking average ranks of all five parameters of CAMEL and they have concluded that private banks are performing better than public sector banks for the period ranging from 2000 to 2011.

[4] Md. Anwarul Kabir and Suman Dey (2012) measured the performance of Selected Private, Commercial Banks in Bangladesh (EXIM & IFIC) using the CAMEL rating for the period of four years. Their finding revealed that in some parameter EXIM was better and in other parameters IFIC was better.

[5] Filiz Kardiyen, H. Hasan Örkcü (2006) compared Principal Component Analysis (PCA) and DEA for ranking of fifteen countries which are members of the Euopen Union in 2002 in financial aspect taking multiple inputs and outputs which yielded constant & valuable results. Then rank correlation test was conducted which showed high correlation between the two methods and at the end simulation study was carried out.
III. OBJECTIVE OF STUDY

- To find out the efficiency of Indian Banks using Data Envelopment Analysis (DEA) based on the performance of Indian Banks and its stock market return.
- To compare the overall performance of Banks in India.

IV. RESEARCH METHODOLOGY

[6] DEA is an operation research technique in finding out the efficiency of different homogenous companies known as Decision Making Units (DMU) when there are multiple inputs or outputs. It’s a non-parametric approach where its initial use was to find the operational efficiency. [2] In the DEA methodology, formally developed by Charnes, Cooper and Rhodes (1978), efficiency is defined as a ratio of weighted sum of outputs to a weighted sum of inputs, where the weights, structure is calculated by means of mathematical programming and constant returns to scale (CRS) are assumed later it in 1984, Banker, Charnes and Cooper developed a model with variable returns to scale (VRS). The variable returns-to-scale (VRS) score represents a more strict “local” definition of efficiency, devoid of the scale effect. Fig. 1 shows the frontier Model for DEA.

We have applied input oriented DEA- VRS model. In general

\[ \text{Efficiency} = \frac{\text{Output}}{\text{Input}} \]  

(1)

When there is one output and input, but DEA can also be applied when the input-output transformation is not known and allows for the following relative efficiency measurement.

\[ \text{Efficiency} = \frac{\text{Weighted Sum of Outputs}}{\text{Weighted Sum of Inputs}} \]  

(2)

Input and output selection could be always be logical and meaningful as efficiency is the ratio of output & input. The sample size (no of DMU’s) used in this analysis is followed a thumb rule coined different researcher. Golany and Roll (1989) establish a rule of thumb that the number of units should be at least twice the number of inputs and outputs considered. Bowlin (1998) mentions the need to have three times the number...
of DMUs as there are input and output variables, \( n \geq \max \{2m + s; 3(m + s)\} \) where \( n \) denotes the number of sample unit, \( s \) for number of outputs and \( m \) is number of Inputs. As for our case for five inputs and one output no of DMUs \( s \geq \max \{10; 18\} \) i.e. 18. These numbers should probably be used as minimums.

[2] The input-oriented VRS technique requires the solution of the following LP problem due to Banker, Charnes, Cooper, 1978 is

Min \( \theta \)

Subject to

\[
\sum_{j=1}^{n} w_j x_{ij} \leq \theta x_i^t; i = 1,2,3...m
\]

\[
\sum_{j=1}^{n} w_j y_{ij} \geq y_i^t; r = 1,2,3...s
\]

\[
\sum_{j=1}^{n} w_j = 1;
\]

\[
w_j \geq 0(j = 1,2,3,...,n);
\]

where \( w_j \) is the weight of the \( j^{th} \) DMU, \( x_{ij} \) is value of the \( i^{th} \) input variables for \( j^{th} \) DMU, \( y_{ij} \) is value of the \( r^{th} \) output variables for \( j^{th} \) DMU and \( x_i^t \) is the value of \( i^{th} \) input variable for \( t^{th} \) DMU. Number of inputs is \( m \), number of outputs is \( s \) and the number of DMU is \( n \). Here the value of \( \theta \) signifies the efficiency of the DMU.

In DEA, DMU’s are ranked according to efficiency score (according to value of \( \theta \)). Problems arise if value of \( \theta \) is equal to one (cent percent) for more than one DMU’s in that case further Super Efficiency analysis was found out to find the most efficient DMU. Super efficiency analysis was developed by Anderson & Peterson (1993).

If ‘it’ is considered of an efficient unit having \( \theta \) is equal to one, then Super efficiency is represented as

Min \( \theta \)

Subject to

\[
\sum_{j=1}^{n} w_j x_{ij} \leq \theta x_{ij}^t; i = 1,2,3...m
\]

\[
\sum_{j=1}^{n} w_j y_{ij} \geq y_{ij}^t; r = 1,2,3...s
\]

\[
\sum_{j=1}^{n} w_j = 1;
\]

\[
w_j \geq 0(j = 1,2,3,...,n);
\]

where \( j \neq t \).

To find the performance of the Indian Banks (which are being traded in the National Stock Index) over the period of ten years, we have used globally accepted CAMEL Rating System as inputs.

[8] As the name suggests CAMEL stands for Capital adequacy, Asset quality, Management soundness, Earnings and Liquidity, which are explained as below are the components in which the banks are assessed.

A. Capital Adequacy

Capital Adequacy Ratio is the ratio which determines the bank’s capacity to meet its liabilities and other risks such as credit risk, operational risk, etc. In the simplest formulation,

\[
\text{CAR} = \frac{\text{Tier 1 Capital} + \text{Tier 2 Capital}}{\text{Risk weighted Assets}}
\]

where Tier 1 Capital is (paid up capital + statutory reserves + disclosed free reserves) - (equity investments in subsidiary + intangible assets + current and losses)

And Tier 2 Capital is Undisclosed Reserves, General Loss reserves, hybrid debt capital instruments and subordinated debts where risk can either be weighted assets.

B. Assets Quality

It measures the asset quality is to ascertain the component of Non-Performing Assets (NPAs) as a percentage of the total assets. Thus, asset quality indicates the type of the debtors the bank is having.

\[
\text{Net NPA to Net advances} = \frac{\text{Closing Balance of Net NPA}}{\text{Advances}}
\]

C. Management Soundness

To find the Management efficiency following Ratio is calculated

\[
\text{Market Value to Equity Capital} = \frac{\text{No of Shares} \times \text{Market Price}}{\text{Net Worth}}
\]

\[
\text{Total Advances to Total Deposits} = \frac{\text{Total Advance}}{\text{Total Deposit}}
\]

\[
\text{Profit per Employee} = \frac{\text{Net Profit}}{\text{No of Employee}}
\]

D. Earnings

Earning quality reflects the quality of a bank’s profitability and its ability to earn consistently over a period of time. This parameter is measured on the basis of three ratios given below

\[
\text{Interest Income to Total Income} = \frac{\text{Interest Earned}}{\text{Total Income}}
\]

\[
\text{Non Interest Income to Total Income} = \frac{\text{Other Income}}{\text{Total Income}}
\]

\[
\text{Net Profit to Avg Assets} = \frac{\text{Net Profit for the year}}{\text{Total Assets}}
\]

E. Liquidity

A high liquidity ratio indicates that the bank is more affluent. To measure the liquidity two ratios are considered as given below:

\[
\text{Liquid assets to Total Assets} = \frac{\text{Cash & Balance with RBI + Balance with Bank}}{\text{Total Assets}}
\]

\[
\text{Liquid assets to Total Deposits} = \frac{\text{Cash & Balance with RBI + Balance with Bank}}{\text{Total Deposits}}
\]

After finding out all the CAMEL parameters which depicts the financial health of the Banks, Data Envelopment Analysis (DEA) was applied to find out the efficiency Indian Banks with respect to its stock market
return. This exercise was carried out to find the investors’ confidence with respect to the financial soundness of the Indian Banks.

Yearly returns in case of Banks were calculated from the formula

\[ \text{Return} = \ln \left( \frac{P_t}{P_0} \right) \times 100 \]

where \( P_t \) is present year closing price (i.e. The closing price of current financial year) and \( P_0 \) is previous year closing price (i.e. The closing price of previous financial year) Then average return of all ten years of Indian Banks was taken as output parameter for further DEA analysis.

V. SAMPLE

In our study eighteen Banks (eight Private Sector and ten Public Sector Banks) were taken into consideration.

Data was collected from published Banks annual reports which are available from individual banks’ websites over a period of ten years from 2004 to 2013. Table I shows the different input variables and output variable for DEA analysis.

<table>
<thead>
<tr>
<th>TABLE I. VARIABLE SPECIFICATION</th>
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<tr>
<td>Capital Adequacy Ratio (C)</td>
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<td>Asset Quality Management (A)</td>
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<td>Management Quality Parameter (M)</td>
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<td>Earnings Quality Parameter (E)</td>
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<td>Liquidity Parameter (L)</td>
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<td>Stock Market Return (average of last 10 years)</td>
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After finding out the CAMEL parameters and respective stock market return as listed in Table II, which served as input and output parameters respectively, for DEA (input oriented VRS Model) analysis, to find the technical efficiency of the Indian Banks. Super Efficiency Model was applied to find the most efficient bank among the banks having an identical score of one. The following results were computed using Lingo 13 demo version. Sample program for input oriented VRS Model for first DMU is given in Appendix A. Super Efficiency was carried out where Banks initially showed the efficiency of cent per cent. Sample program for Super Efficiency is given in Appendix B. The following Table II and Table III shows the ranking of Indian Banks in terms of its efficiency level.

<table>
<thead>
<tr>
<th>TABLE III. EFFICIENCY TABLE (INPUT ORIENTED VRS)</th>
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<tr>
<td>Banks</td>
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<td>SBI</td>
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<td>Kotak Mahindra</td>
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<td>Federal</td>
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<td>Karurvyssa</td>
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<td>Dhanlaxmi</td>
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</table>

According to our finding Axis bank is a most efficient bank, and then comes HDFC and Karurvyssa whereas ICICI had taken a backseat, marginally better were SBI and Canara Bank.

VII. CONCLUSION

Out of top nine banks six banks are private banks and there are public sector banks, which conclude that private banks are a better performer. Axis bank had topped the overall list and then comes HDFC in efficiency scale. ICICI Bank is the only private bank, which has below average ranking and taken back most seats, but in public sector banks Oriental & Andhra Banks are efficient and SBI and BOI were most inefficient.

APPENDIX A SAMPLE PROGRAM FOR INPUT ORIENTED VRS MODE OF STATE BANK OF INDIA (DMU 1)

Min = \theta;
\[0.0148w_1 + 0.3268w_2 + 0.3316w_3 + 0.3486w_4 + 0.3372w_5 + 0.3228w_6 + 0.3374w_7 + 0.3348w_8 + 0.3386w_9 + 0.3397w_{10} + 0.3183w_{11} + 0.3078w_{12} + 0.3419w_{13} + 0.3536w_{14} + 0.3372w_{15} + 0.3616w_{16} + 0.3256w_{17} + 0.3146w_{18} \leq 0.3198\theta;\]

\[0.0250w_1 + 0.0080w_2 + 0.0082w_3 + 0.0114w_4 + 0.0164w_5 + 0.0221w_6 + 0.00139w_7 + 0.0102w_8 + 0.0059w_9 + 0.0143w_{10} + 0.0032w_{11} + 0.0064w_{12} + 0.0136w_13 + 0.0106w_14 + 0.0116w_15 + 0.0064w_{16} + 0.0148w_{17} + 0.2279w_{18} \leq 0.0205\theta;\]

\[0.0164w_5 + 0.0221w_6 + 0.00139w_7 + 0.0102w_8 + 0.0059w_9 + 0.0143w_{10} + 0.0032w_{11} + 0.0064w_{12} + 0.0136w_{13} + 0.0106w_{14} + 0.0116w_{15} + 0.0064w_{16} + 0.0148w_{17} + 0.2279w_{18} \leq 0.0205\theta;\]

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Avijan Dutta has obtained his Post Graduation in Management from IIM Ahmadabad and received his PhD degree from Jadavpur University. He was awarded with Silver Medal for Best Research Paper at Association of Indian Management School. His area of research interest are Capital Market and Investment management and is presently serving NIT Durgapur as Associate Professor and

Gautam Bandyopadhyay has obtained his PhD from Jadavpur University is also a fellow member of the Institute of Cost & Works Accountants. He is presently guiding a good number of PhD students and has already produced PhD too. He is presently serving NIT Durgapur as Associate Professor.