Performance evaluation of district central co-operative banks in India: A data envelopment analysis

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Abstract
Cooperative banks play an important role in the Indian banking system. In this paper, Data Envelopment Analysis (DEA) model is applied to evaluate the efficiency of District Central Cooperative Banks (DCCB) in India. DEA is a mathematical modeling technique used to evaluate the relative efficiency of Decision making units (DMUs). We considered each DCCB as a Decision making unit. Nineteen DCCB functioning in India are taken into an account for the analysis. Banker Charnes Cooper (BCC) Output - oriented model allowing variable returns to scale (VRS) is applied. It is found that Karnataka DCCB is inefficient compared to its peers. The projection analysis is carried out for this DMU and it reveals that it has to make improvement into output.

Keywords: Data Envelopment analysis, Decision making units, district central cooperative bank, banker, Charnes and Cooper, variable returns to scale

Introduction
A cooperative bank is a financial entity that belongs to its members, who are owners and customers of their own bank. Cooperative banks are often created by persons belonging to the same local or professional community or sharing a common interest. Cooperative banks generally provide their members with a wide range of banking and financial services (loans, deposits, banking accounts etc.). Cooperative banks differ from stockholder banks by their organization, goals, values and governance. In most countries, they are supervised and controlled by banking authorities and have to respect prudential banking regulations, which put them at a level playing field with stockholder banks. Depending on countries, this control and supervision can be implemented directly by state entities or delegated to a cooperative federation or central body. Cooperative banking is retail and commercial banking organized on a cooperative basis.

The central cooperative banks are located at the district headquarters or some prominent town of the district. For the cooperative banks in India, cooperatives are organized groups of people and jointly managed and democratically controlled enterprises. They exist to serve their members and depositors and produce better benefits and services for them. Cooperative banks have completed 100 years of existence in India. They play a very important role in the financial system. The cooperative banks in India form an integral part of our money market today.

The cooperative banking structure is a three tier federal one and it include
- A State Cooperative Bank works at the apex level
- The Central Cooperative Bank works at the Intermediate Level.
- Primary Cooperative credit societies at base level

DCCB’s are the federations of primary credit societies in a district and are of two types those having a membership of primary societies only and those having a membership of societies as well as individuals. The funds of the bank consist of share capital, deposits, loans and overdrafts from state cooperative banks and joint stocks. These banks provide finance to member societies within the limits of the borrowing capacity of societies. They also conduct all the business of a joint stock bank.
All over the world, number of studies has applied DEA to the question of efficiency in commercial banking but very little empirical research can be observed in India. The authors are the opinion that only a limited number of studies has been carried out with using modeling approach. This has been motivated the authors to study the efficient DCCB.

**Review of Literature**

Farrel (1957)\(^1\) is considered to be the most influential paper on DEA. The further pioneering contributions were made by CCR (1978, 1979)\(^2, 3\) and CCR (1981)\(^4\), Banker, Charnes and Cooper (1984)\(^5\) and Charnes et al (1985)\(^6\). Banker and Morey (1986) have evaluated the relative technical and scale efficiencies of DMUs by means of mathematical programming formulations when some of the inputs and outputs are exogenously fixed and beyond the discretionary control of DMU personnel.


Asmild et al (2007)\(^15\) developed procedures for measuring overall efficiency and effectiveness using DEA. Sahoo, B.K., Sengupta, J.K., and Mandal, A. (2007)\(^16\), Sunilkumar and Rachita Gulati. (2008)\(^17\) Dwivedi A.K. & Charyulu D.K., (2011)\(^18\), are among those few researchers who have examined performance of the Indian commercial banks. They have mainly considered the reform impact and different ownership groups e.g. Public, private and foreign.

**DEA Approach**

DEA is a mathematical modeling technique for the analysis of the relative efficiency of DMUs with multiple inputs and multiple outputs. It is based on Linear Programming problem and it determines the efficient frontier by evaluating all DMUs and each unit has r outputs and k inputs. Efficiency of observed DMU (\(z_0^0\)) is defined as follow

\[
\begin{align*}
\max & \quad z_0 \\
\text{Subject to} & \quad \sum_{j=1}^{r} v_j y_{j0} - \sum_{i=1}^{k} u_i x_{i0} \leq 0 \\
& \quad v_j, u_i \geq 0
\end{align*}
\]

Where \(j = 1, ..., r\), \(i = 1, ..., k\), \(y_{j0}\) = \(j\) th output of observed DMU, \(v_j\) = weight of that output, \(x_{i0}\) = \(i\) th input of observed DMU, \(u_i\) = weight of that input.

The above fractional programming problem can be converted in to a linear program by normalizing either the numerator or denominator. Here we normalize the denominator i.e the weighted sum of inputs equal to unity. Therefore, the above fractional programming problem reduced to

\[
\begin{align*}
\max & \quad z_0 = \sum_{j=1}^{r} v_j y_{j0} \\
\text{Subject to} & \quad \sum_{i=1}^{k} u_i x_{i0} = 1 \\
& \quad \sum_{j=1}^{r} v_j y_{j0} - \sum_{i=1}^{k} u_i x_{i0} \leq 0 \\
& \quad v_j, u_i \geq 0
\end{align*}
\]

The above model should be solved for \(N\) times one for each DMU. When it is solved, it gives relative efficiency scores \(z_0^0 (0 \leq z_0^0 \leq 1)\), input and output weights. In general, a DMU is considered to be efficient if it obtains a score of 1 and inefficient if it sets scores less than 1.

According to the theory of duality in Linear programming problem (LPP) every primal has its own dual so the dual LPP corresponding to above primal is

\[
\begin{align*}
\min & \quad \theta \\
\text{Subject to} & \quad \sum_{i=1}^{N} x_{i0} \lambda_i \leq \theta x_{i0}, \quad i = 1, ..., k \\
& \quad \sum_{i=1}^{N} y_{j0} \lambda_i \geq y_{j0}, \quad j = 1, ..., r \\
& \quad \lambda_i \geq 0, \quad s = 1, ..., N
\end{align*}
\]

where \(\theta\) is the Efficiency score and \(\lambda_i\) is the weight of DMUs when the above model is solved for each DMU in the set, it gives an efficiency score \(\theta\) and DMU weights \(\lambda_i\). The factor \(\theta\) needed to reduce the input of observed DMU to a frontier formed by its peers, or convex combinations of them, which produce no less output than observed DMU. The DMU will be efficient if \(\theta\) equal to one and all slacks equal to zero. If \(\theta\) is less than one then DMU will be inefficient. Then the composite unit provides targets for the inefficient unit and \(\theta\) represents the maximum inputs that a DMU should be using to attain at least its current output.

The above model is Charnes, Cooper and Rhodes (CCR) which allows constant returns to scale. The other model known as BCC and it allows variable returns to scale. Banker...
Charnes and Cooper modified CCR model by introducing the constraint \( \sum_{s=1}^{N} \lambda_s = 1 \) is called convexity constraint.

Output oriented BCC model used in the study for the analysis of efficiency is given below.

**Output- Oriented BCC Model (BCC)**

\[
\begin{align*}
\text{Max } \phi &= Y^\lambda \\
\text{s.t. } Y \lambda &\geq \phi Y_0 \\
X \lambda &\leq X_0 \\
\sum_{s=1}^{N} \lambda_s &= 1 \\
\lambda &\geq 0,
\end{align*}
\]

where \( \phi \) = Efficiency Measure, \( X = [X_1, X_2, \ldots, X_N] \) = Vector of Inputs
\( Y = [Y_1, Y_2, \ldots, Y_N] \) = Vector of Outputs
\( \lambda = [\lambda_1, \lambda_2, \ldots, \lambda_N] \) = Vector of Weights
\( Y_0 \) = output of the observed DMU,
\( X_0 \) = input of the observed DMU
\( \lambda_s \) = \( s \)th output of efficiency is given below.

Solving the above model it gives \( \phi \) which is the optimal efficiency score satisfies \( \phi \geq 1 \), with \( \phi = 1 \) indicating efficient unit and \( \phi > 1 \) indicating extent of radial inefficient related to best practice DMU in the sample and simultaneously extent to which all outputs increased proportional with given input level to project inefficient DMU onto frontier.

**Empirical Analysis**

The data for this study are taken from “Basic Data on performance District Central Cooperative banks 2011-2012” published by National Federation of State Cooperative Banks Ltd, Mumbai. This study covers 19 state district cooperative banks and mainly emphasis on totally nine variables include C/D ratio which we generate on a special interest.

Collection demand ratio (C/D ratio) defined as = (Collection / Demand) * 100

DCCB’s follows intermediation approaches, banks primarily intermediating funds between savers and investors under this approach. Nine variables including six inputs and three outputs are considered in this study.

Inputs: Number of Offices, Number of Employees, Paid up Capital, Total Deposits, Cost of Management and Working Capital.

Outputs: Investments, Total Loans & Advances and Collection demand ratio (C/D ratio)

**Computations**

The following table shows the descriptive statistics of the sample n=19 banks.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Offices</td>
<td>710.26</td>
<td>811.00</td>
<td>120</td>
<td>3737</td>
<td>19</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>4526.11</td>
<td>5460.94</td>
<td>596</td>
<td>25299</td>
<td>19</td>
</tr>
<tr>
<td>Paid up Capital</td>
<td>43099.58</td>
<td>49441.32</td>
<td>493</td>
<td>187338</td>
<td>19</td>
</tr>
<tr>
<td>Total Deposits</td>
<td>930644.11</td>
<td>1079581.46</td>
<td>54835</td>
<td>4867429</td>
<td>19</td>
</tr>
<tr>
<td>Cost of Management</td>
<td>30867.79</td>
<td>30814.16</td>
<td>1932</td>
<td>136406</td>
<td>19</td>
</tr>
<tr>
<td>Working Capital</td>
<td>1354243.32</td>
<td>1443258.51</td>
<td>61757</td>
<td>6508574</td>
<td>19</td>
</tr>
<tr>
<td>Investments</td>
<td>474793.74</td>
<td>497418.13</td>
<td>44373</td>
<td>2281322</td>
<td>19</td>
</tr>
<tr>
<td>Total Loans &amp; Advances</td>
<td>855549.05</td>
<td>82933.98</td>
<td>1920</td>
<td>3169819</td>
<td>19</td>
</tr>
<tr>
<td>C/D Ratio</td>
<td>743445</td>
<td>174331</td>
<td>20.66</td>
<td>93.56</td>
<td>19</td>
</tr>
</tbody>
</table>

The above table shows that District Central Co-operative banks between 120 and 3737 operate through the country. An average of 710.26 banks operating to get the maximum deposit Rs 4867429 in selected 19 states.

**Efficiency score of Variable returns to scale**

<table>
<thead>
<tr>
<th>DMU</th>
<th>VRS TE</th>
<th>Peers Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>1.000</td>
<td>( \lambda_1=1.000 )</td>
</tr>
<tr>
<td>Bihar</td>
<td>1.000</td>
<td>( \lambda_2=1.000 )</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>1.000</td>
<td>( \lambda_3=1.000 )</td>
</tr>
<tr>
<td>Gujarat</td>
<td>1.000</td>
<td>( \lambda_4=1.000 )</td>
</tr>
<tr>
<td>Haryana</td>
<td>1.000</td>
<td>( \lambda_5=1.000 )</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>1.000</td>
<td>( \lambda_6=1.000 )</td>
</tr>
<tr>
<td>Jammu And Kashmir</td>
<td>1.000</td>
<td>( \lambda_7=1.000 )</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>1.000</td>
<td>( \lambda_8=1.000 )</td>
</tr>
<tr>
<td>Karnataka</td>
<td>1.007</td>
<td>( \lambda_9=1.000 )</td>
</tr>
<tr>
<td>Kerala</td>
<td>1.000</td>
<td>( \lambda_{10}=1.000 )</td>
</tr>
<tr>
<td>Madya Pradesh</td>
<td>1.000</td>
<td>( \lambda_{11}=1.000 )</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>1.000</td>
<td>( \lambda_{12}=1.000 )</td>
</tr>
<tr>
<td>Orissa</td>
<td>1.000</td>
<td>( \lambda_{13}=1.000 )</td>
</tr>
<tr>
<td>Punjab</td>
<td>1.000</td>
<td>( \lambda_{14}=1.000 )</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>1.000</td>
<td>( \lambda_{15}=1.000 )</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>1.000</td>
<td>( \lambda_{16}=1.000 )</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>1.000</td>
<td>( \lambda_{17}=1.000 )</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>1.000</td>
<td>( \lambda_{18}=1.000 )</td>
</tr>
<tr>
<td>West Bengal</td>
<td>1.000</td>
<td>( \lambda_{19}=1.000 )</td>
</tr>
</tbody>
</table>

\[ \lambda_9=0.044, \lambda_{14}=0.180, \lambda_{16}=0.291, \lambda_{18}=0.485 \]
Projection analysis

Table 3: Projection analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Original value</th>
<th>Radial movement</th>
<th>Slack movement</th>
<th>Target value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investments</td>
<td>320666.000</td>
<td>2343.631</td>
<td>25149.906</td>
<td>348159.537</td>
</tr>
<tr>
<td>Total Loans &amp; Advances</td>
<td>992941.000</td>
<td>7257.043</td>
<td>0.000</td>
<td>1000198.043</td>
</tr>
<tr>
<td>C/D Ratio</td>
<td>91.610</td>
<td>0.670</td>
<td>0.000</td>
<td>92.280</td>
</tr>
<tr>
<td>Number of Offices</td>
<td>596.000</td>
<td>0.000</td>
<td>-80.724</td>
<td>515.276</td>
</tr>
<tr>
<td>Number of Employees</td>
<td>4223.000</td>
<td>-1450.192</td>
<td>2773.808</td>
<td></td>
</tr>
<tr>
<td>Paid-up Capital</td>
<td>44146.000</td>
<td>0.000</td>
<td>0.000</td>
<td>44146.000</td>
</tr>
<tr>
<td>Total Deposits</td>
<td>827970.000</td>
<td>0.000</td>
<td>0.000</td>
<td>827970.000</td>
</tr>
<tr>
<td>Cost of Management</td>
<td>36195.000</td>
<td>0.000</td>
<td>-6122.884</td>
<td>30072.116</td>
</tr>
<tr>
<td>Working Capital</td>
<td>1359678.000</td>
<td>0.000</td>
<td>-88559.572</td>
<td>1271118.428</td>
</tr>
</tbody>
</table>

Table 3 shows that projection analysis for inefficient DMU Karnataka. In this state operating 596 district central cooperative banks, reduce 81 banks through slack movements to attain optimum level.

Summary and Conclusion

In this study mainly focuses on performance evaluation of district central cooperative banks in India. It is observed that 18 banks are efficient and 1 bank is inefficient. The inefficient bank viz., Karnataka has to increase 0.7% of their outputs with the same amount of inputs that is currently employed. The state Karnataka could improve its efficiency by comparing all its inputs and outputs to its peers. The convex combination of the peers gives the inefficient DMUs of Karnataka could maximize its first outputs through radial and slack movement. Futher second and third output could attain its maximum level through radial movement only.

References