CHAPTER - 5

Summary & Conclusions
CHAPTER - V

SUMMARY AND CONCLUSIONS

5.0. SUMMARY

The present study evaluated output technical efficiency by postulating a translog output distance function. The concept of output distance function was initiated by R.W. Shephard (1953). The inverse of this function measures output technical efficiency.

Shephard’s Output Distance Function:

\[
[D_o(x,u)]^{-1} = \text{Max}\{\theta: \theta u \in p(x)\}
\]

where \(D_o(x,u)(\leq 1)\) is the output distance function whose inverse measures output technical efficiency, \(p(x)\) is output level set, \(\theta\) refers to proportional expansion of outputs. The translog version of output distance function is as follows:

\[
\ln D_o(x,u) = \beta_0 + \sum \beta_i \ln x_i + \frac{1}{2} \sum \sum \beta_{ij} \ln x_i \ln x_j + \sum \alpha_i \ln u_i \\
+ \frac{1}{2} \sum \sum \alpha_{ip} \ln u_i \ln u_p + \sum \sum \gamma_{ij} \ln x_i \ln u_j
\]  

\(\cdots (5.1)\)

The translog input distance function with three inputs and three outputs may be expressed as,

\[
\ln D(u,x) = \alpha_o + \sum \alpha_i \ln x_i + \sum \beta_i \ln u_i + \frac{1}{2} \sum \sum \alpha_{ii} (\ln x_i) \ln x_i \\
+ \frac{1}{2} \sum \sum \beta_{ip} (\ln u_i)(\ln u_p) + \sum \sum \gamma_{ij} (\ln x_i)(\ln u_j)
\]  

\(\cdots (5.2)\)

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The input distance function $D(u,x)$ is linear homogeneous in inputs.

$$[D(u,x)]^{-1} = \text{Min} \{ \lambda : \lambda x \in L(u) \}$$

$$[D(u,\delta x)]^{-1} = \delta^{-1} \text{Min} \{ \lambda \delta : \lambda \delta x \in L(u) \}$$

$$= \delta^{-1} [D(u,x)]^{-1}$$

$$D(u,\delta x) = \delta D(u,x) \quad \ldots (5.3)$$

This property imposes parametric restrictions on the parameters of translog distance function.

$$\alpha_1 + \alpha_2 + \alpha_3 = 1$$

$$\alpha_{11} + \alpha_{12} + \alpha_{13} = 0$$

$$\alpha_{21} + \alpha_{22} + \alpha_{23} = 0$$

$$\alpha_{31} + \alpha_{32} + \alpha_{33} = 0$$

$$\gamma_{11} + \gamma_{12} + \gamma_{13} = 0 \quad \ldots (5.4)$$

$$\gamma_{21} + \gamma_{22} + \gamma_{23} = 0$$

$$\gamma_{31} + \gamma_{32} + \gamma_{33} = 0$$

If $(x,u)$ is an efficient production plan, then,

$$D(u,x) = 1 \quad \ldots (5.5)$$
Combine (5.2.) and (5.5) to get,

\[ \alpha_0 + \sum_{i=1}^{3} \alpha_i \ln x_i + \sum_{j=1}^{3} \beta_j \ln u_j + \sum_{i=1}^{3} \sum_{k=1}^{3} \alpha_{ik} (\ln x_i) \ln x_k \]

\[ + \sum_{j=1}^{3} \sum_{k=1}^{3} \beta_{jk} (\ln u_j) (\ln u_k) + \sum_{i=1}^{3} \sum_{k=1}^{3} \gamma_i (\ln x_i) (\ln u_k) = 0 \]  \quad \ldots (5.6)

Combining (5.4) and (5.6) we obtain,

\[ -\ln x_i = \alpha_0 + \alpha_{1i} \ln x_i + \alpha_{2i} \ln x_i + \beta_{1i} \ln u_i + \beta_{2i} \ln u_i + \beta_{3i} \ln u_i \]

\[ + \frac{1}{2} \alpha_{ii} (\ln x_i)^2 + \alpha_{ij} \ln x_i \ln x_j + \beta_{ii} (\ln u_i)^2 \]

\[ + \frac{1}{2} \beta_{ii} (\ln u_i)^2 + \beta_{ij} \ln u_i \ln u_j + \beta_{1i} \ln u_i \ln u_1 + \beta_{2i} \ln u_i \ln u_2 + \beta_{3i} \ln u_i \ln u_3 \]  \quad \ldots (5.7)

\[ + \gamma_{1i} \ln x_i (\ln u_i) + \gamma_{ij} \ln x_i (\ln u_j) + \gamma_{1j} \ln x_j (\ln u_i) \]

\[ + \gamma_{ij} \ln x_i (\ln u_j) + \gamma_{2j} \ln x_j (\ln u_i) + \gamma_{3j} \ln x_j (\ln u_3) \]

There are 21 translog parameters to be estimated from the above function.

Selection of inputs and outputs is the primary step in data envelopment analysis. One should be parsimonious in the selection of inputs and outputs. If an additional input is to be augmented to DEA analysis, the BCC constraints will increase by one and the BCC output technical efficiencies decrease and move closer to unity. Consequently, the number of output efficient decision making units will increase and DEA looses its discriminatory power. In DEA if
inputs are m and outputs are n in number, then (m+n) DMUs emerge to be output technical efficient. In this case DEA requires 2(m+n) observations.

The translog output distance function has been estimated by using two methods namely, Maximum likelihood method of estimation and corrected ordinary least squares method of estimation. Further, a nonparametric approach namely DEA has been applied to measure the efficiency of production by constructing several linear programming problems based on output distance function.

5.1. CONCLUSIONS

The present study makes use of data envelopment analysis models and the concept of translog output distance function the later is estimated by the stochastic frontier approach to study efficiency variation among 51 Indian commercial banks out of which 28 are public sector banks and 23 are private sector banks. The data published in the Reserve Bank of India bulletins are considered for the efficiency study. The study uses data on three DEA inputs and three DEA outputs. The DEA inputs are (1) Number of employees, (2) Fixed assets and (3) Non-performing assets. The DEA outputs are (1) Deposits, (2) Loans and advances and (3) Investments.

The CCR (1978) and BCC (1984) problems are solved for 51 commercial bank with the help of the following linear programming problems.

(i) \( \lambda(CCR) = \min \lambda \)

subject to

\[ \sum_{i=1}^{n} \lambda_i x_{i} \leq \lambda x_{o}, \quad i=1,2,3. \]

\[ \sum_{j=1}^{m} \lambda_j u_{r} \geq u_{o}, \quad r=1,2,3. \]  

... (5.8)

\[ \lambda_j \geq 0 \]
(ii) \( \lambda(BCC) = \min \lambda \)

Subject to
\[
\sum_{j=1}^{m} \lambda_j x_{ij} \leq \lambda x_i, \quad i=1,2,3.
\]
\[
\sum_{j=1}^{m} \lambda_j u_{ij} \geq u_i, \quad i=1,2,3.
\]
\[
\sum_{j=1}^{m} \lambda_j = 1
\]

Among the 28 public sector banks the IDBI Bank Ltd., is overall technical efficient. The remaining public sector are observed to be overall technical inefficient. The banks falling at the bottom are State Bank of India and State Bank of Saurashtra. The State Bank of India due to largest size is suppose to suffer from decreasing return to scale. Among 23 private sector banks six banks are overall technical efficient. These banks are bank of Rajasthan, City Union Bank, IndusInd Bank, Nainital Bank, Ratnakar Bank, SBI Comm & Intl Bank. The private sector bank that lies at the bottom is Kotak Mahindra Bank, it experiences 43 per cent of input losses due to overall technical inefficiency.

**TABLE 5.1**

**DEA - OVERALL TECHNICAL EFFICIENCY**

<table>
<thead>
<tr>
<th>Bank</th>
<th>Mean</th>
<th>SE</th>
<th>t - Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public sector banks</td>
<td>0.8947</td>
<td>0.0100</td>
<td>0.2616 NS</td>
</tr>
<tr>
<td>Private sector banks</td>
<td>0.9086</td>
<td>0.0194</td>
<td></td>
</tr>
</tbody>
</table>

*NS: Not Significant at 5% level.*
The Overall Technical Efficiency (OTE) estimates obtained above reveals that 14 out of 28 public sector banks have consistently shown OTE above to the average OTE. Where as the remaining 14 banks registered its OTEs below to the average OTE. In case of private sector banks 12 banks have consistently shown OTE above to the average and the remaining 11 banks registered its OTEs below to the average OTE.

It is observed from the application of t-Test that is no significant difference between public sector and private sector banks with reference to the overall technical efficiencies.

A commercial bank that does not experience any input losses under constant return to scale is always pure technical and scale efficient. It has been observed from the analysis that 36 percent of the public sector banks and 56 per cent of the private sector banks are input pure technical efficient attaining 100 per cent efficiency score. The remaining 64 per cent of public sector banks and 44 per cent of the private sector banks experienced input losses due to input pure technical inefficiency.

| TABLE 5.2 |
| DEA - PURE TECHNICAL EFFICIENCY |

<table>
<thead>
<tr>
<th>Bank</th>
<th>Mean</th>
<th>SE</th>
<th>t - Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public sector banks</td>
<td>0.9625</td>
<td>0.0089</td>
<td>0.4742 NS</td>
</tr>
<tr>
<td>Private sector banks</td>
<td>0.9613</td>
<td>0.0160</td>
<td></td>
</tr>
</tbody>
</table>

NS: Not Significant at 5% level.

The Pure Technical Efficiency (PTE) estimates obtained above reveals that 18 out of 28 public sector banks have consistently shown PTE above to the average PTE. Where as the remaining 10 banks registered its PTEs below to the average PTE. In case of private sector banks 16 banks have consistently
shown PTE above to the average and the remaining 7 banks registered its PTEs below to the average PTE.

It is observed from the application of t-Test that is no significant difference between public sector and private sector banks with reference to the Pure technical efficiencies.

Any departure of return to scale from constant return to scale leads to scale inefficiency. The commercial banks shall expand their activities if they are operating at increasing returns to scale and contract their scale of operation if they are operating at decreasing return to scale. Among all 28 public sector banks the IDBI bank limited is found to be scale efficient. All other commercial banks experienced decreasing returns to scale. The State Bank of India due its size suffered heavy input losses compared to other public sector banks. Among the private sector banks six banks attained input scale efficiency.

<table>
<thead>
<tr>
<th>TABLE 5.3</th>
<th>DEA - SCALE EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank</td>
<td>Mean</td>
</tr>
<tr>
<td>Public sector banks</td>
<td>0.9297</td>
</tr>
<tr>
<td>Private sector banks</td>
<td>0.9443</td>
</tr>
</tbody>
</table>

*NS: Not Significant at 5% level.*

The Scale Efficiency (SE) estimates obtained above reveals that 23 out of 28 public sector banks have consistently shown SE above to the average scale efficiency. Where as the remaining 5 banks registered its SEs below to the average SE. In case of private sector banks 14 banks have consistently shown SE above to the average and the remaining 9 banks registered its SEs below to the average SE.
It is observed from the application of t-Test that there is no significant difference between public sector and private sector banks with reference to the Pure technical efficiencies.

The most popular role model bank is the one with largest peer count. In the present study, it has been observed that Central Bank of India appears as an efficient peer bank in the peer list of 17 inefficient banks. Nainital Bank served as efficient peer of 14 inefficient public and private sector banks. Subsequent efficient peer banks are Syndicate Bank and Bank of Rajasthan. Each of these two banks was found in the peer list of 12 inefficient commercial banks.

The distance function, which is translog approximation is estimated by ordinary least squares estimation procedure. The parametric estimates obtained are almost equal to maximum likelihood estimates. Out of 21 parameters 10 parameters are statistically significant, 2 at 5 per cent and the remaining 9 at one per cent level of significant.

TABLE 5.4
STOCHASTIC FRONTIER (TECHNICAL EFFICIENCIES) OF BANKS

<table>
<thead>
<tr>
<th>Bank</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>Coefficient of variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public sector banks</td>
<td>0.9208</td>
<td>0.0258</td>
<td>0.8549</td>
<td>0.9574</td>
<td>2.8075</td>
</tr>
<tr>
<td>Private sector banks</td>
<td>0.9242</td>
<td>0.0249</td>
<td>0.8511</td>
<td>0.9658</td>
<td>2.6980</td>
</tr>
</tbody>
</table>

The technical efficiency estimates obtained by stochastic frontier approach reveals that 15 out of 28 public sector banks have consistently shown technical efficiency above to its average technical efficiency, where as the remaining 13 banks registered their efficiencies below to the average technical efficiency. Among the 28 public sector bank the Oriental Bank of Commerce ranked first where as Bank of Maharasstra ranked last.
In case of private sector banks 14 banks have consistently shown TE above to the average technical efficiency and the remaining nine banks registered efficiencies below to the average. Among these private sector banks Axis Bank ranked first whereas Catholic Syrian Bank ranked last. Lastly, it has been observed that the overall performance of private sector banks is better than public sector banks.

5.2. SUGGESTIONS FOR FURTHER RESEARCH

i. Slack based efficiency

ii. Directional efficiency

iii. Non-Radial measures of efficiency

May also be considered to examine these banks and to provide appropriate policy proposals.