INTRODUCTION

Indian Commercial Banks

1.1 Indian commercial banking is constituted by public, private and foreign sector banks. Public Sector Banks share 70 percent of the bank business. The activities of Public Sector Banks are found widespread in rural India. Prior to nationalization large banks played the role of financial intermediaries whose prime activities were deposit collection and distribution of advances. These banks functioned with only one motive, namely maximization of profit, credit needs of rural sector and small scale industries were grossly ignored. In 1969 fourteen large banks were nationalized and the spectrum of objectives of the national banks enlarged. In the year 1980 another six banks were nationalized. The environment of public sector banks was greatly influenced by the policies of central government and the regulatory measures of the Central Bank (Reserve Bank of India). Financial repression was manifested in the year 1991. The first stage reforms were implemented in the same year, before this to happen the public sector banks suffered from NPAs growing at an alarming rate.

To improve the functioning of the Commercial Banks, the Central Government and the Central Bank introduced anti-repression policies basing on Narasimham Report in 1991. Another set of reforms (Second stage) were introduced in the year 1998 based on Narasimham Committee Report (II), the consequent deregulation led commercial banks to explore new avenues towards profit maximization. The capital adequacy of Indian commercial banks is beyond international norm, net profits increased, for a while NPAs diminished. After deregulation the public sector banks experienced fierce competition from private sector banks that led to a decline in their Deposits, Investments, Advances and Total Assets.

A commercial bank may be modelled by the Production Approach, Intermediation Approach and Profit Approach. In Production Approach banks’ inputs produce outputs. In this approach labour and capital produce deposits and advances. Production approach is best suited to measure Bank Branch Efficiency (Berger and Humphrey 1997; Camanho and Dyson, 1999).
In Intermediation Approach Banks use Labour, Capital and Deposits to produce advances and other financial products. In Profit Approach inputs are interest expenditure and other expenditure, and outputs are interest income and other income.

The present study models a Commercial Bank by Profit Approach. Interest expenditure and Other expenditure amount to total expenditure, while Interest income and Other income comprise total revenue. These four variables capable of defining profit integrate all the activities of Commercial Banks.

Several researchers studied the performance of Banks and Bank Branches. There is no consensus towards choice the appropriate model or in the selection of DEA inputs and outputs (Humphrey, 1985; Berg et al., 1991, 1993; Tulkens, 1993; Brocket et al., 1997; Kumbhakar et al., 1998; Sathye, 2001; Simar and Wilson, 2007; Banker and Natarajan, 2008; Hakimi et al., 2012).

1.2 TWO STAGE DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis (DEA) is a linear programming tool, used to measure efficiency scores of decision making units (DMUs) and to set efficiency targets for inefficient DMUs. Charnes, Cooper and Rhodes (CCR, 1978) introduced multiplier problems to evaluate radial input/output technical efficiency scores. Their DEA model fails to recognize returns to scale differences among DMUs.

The CCR model was subsequently generalized by Banker, Charnes and Cooper (BCC, 1984) to provide input/output technical efficiency measures that are free from returns to scale effects. The BCC measure provides pure technical efficiency.

Both the DEA models enquire proportionate input contraction/output expansion while inefficient production plan is projected on to the frontier of the production possibility set.

Since input contraction/output expansion are radial, along the projection path, input mix/output mix remains to be the same. That is, change of technique can not take place. Since CCR/BCC efficiency scores are found holding the technique same, they are called input/output technical efficiency scores.
Input technical efficiency scores are found via proportional contraction of the given input vector holding the output vector constant.

Output technical efficiency scores are found via proportional expansion of outputs holding input vector constant.

A production unit that is BCC-efficient need not be CCR-efficient. A DMU which is CCR efficient should necessarily be BCC efficient. Such DMU is said to be scale efficient.

Scale efficiency is derived efficiency score which is the ratio of CCR efficiency score to BCC efficiency score.

As an output of first stage DEA we evaluated input technical efficiency scores for 27 Indian Commercial Banks. The input scale efficiency scores are evaluated, following,

\[ \theta_{SE} = \frac{\theta_{CCR}}{\theta_{BCC}} \]  

(1.2.1)

where \( \theta_{CCR} \) is input over all technical efficiency score

\( \theta_{BCC} \) is input pure technical efficiency score

\( \theta_{SE} \) is input scale efficiency score

\[ 0 \leq \theta_{CCR}, \theta_{BCC}, \theta_{SE} \leq 1 \]

In the second stage DEA, an attempt is made to explain interbank differences by regression analysis.


The choice of regression model to explain inter bank differences reflected by the efficiency scores is not trivial, since the efficiency scores are fractional.
The alternative regression models are Linear Probability Regression, Latent Variables Regression, Logit Regression, Probit Regression, Fractional regression (Papke and Wooldridge, 1996), Generalized Fractional Regression (Ramalho et al., 2010), Stochastic Frontier Regression (Banker and Natarajan, 2008), Bootstrap Regression (Simar and Wilson, 2007).

In the present study we employed Binary Regression, whose disturbance term follows Standard Logistic Distribution.

Due to data constraints, Non-performing Assets (NPAs), Bank Size measured by total assets and income from Off Balance Sheet (OBS) business are choosen as environmental variables. It is hypothesized that the variation in the pure technical efficiency scores can be explained by these environmental variables. The binary regression equation specified is as follows:

\[ y_j = \beta_0 + \beta_N z_{Nj} + \beta_S z_{Sj} + \beta_O z_{Oj} + \varepsilon_j, \quad j=1,2,\ldots,n \]

where \( y_j = 1 \) if \( \theta_{BCC} = 1 \)

\[ = 0 \text{ if } \theta_{BCC} < 1 \]

\( z_{N}, z_{S} \) and \( z_{O} \) respectively measure net NPAs, Size and income from Off Balance Sheet Business (OBS).

To fit (1.2.2) we have used SPSS.

1.3 DATA: The Data are collected from Reserve Bank of India Bulletins (2016).

Inputs: Interest Expenditure \( (x_1) \)

Other Expenditure \( (x_2) \)

Outputs: Interest Income \( (y_1) \)

Other Income \( (y_2) \)
Environmental variables: Net NPAs \( (z_N) \)

Bank Size \( (z_S) \) = Total Assets.

Income from Off Balance Sheet Business \( (z_O) \)

(Money values are expressed in crores of rupees)

1.4 OBJECTIVES OF THE STUDY

i) To evaluate input overall (CCR)/pure technical efficiency (BCC) scores for Indian Public Sector Banks.

ii) To evaluate input scale efficiency scores for PS Banks.

iii) To explain inter bank differences, regressing environmental variables on pure technical efficiency scores generated binary dependent variable, under the assumption that the disturbance term follows Standard Logistic Distribution.

iv) To identify the most Robust Bank from among public sector banks.

v) To enhance the discriminatory power of Data Envelopment Analysis by means of predicted probabilities of efficient banks to remain efficient.

vi) To rank the banks by means of predicted probabilities of efficient banks to remain efficient.

vii) To rank the banks evaluating super efficiencies for the efficient banks, by Directional Distance Function Approach.

viii) To examine the agreeability of the two sets of ranks, by computing and testing the Spearman’s rank correlation coefficient.

ix) To set efficient input and output targets to inefficient Public Sector Banks.

x) To evaluate non-radial efficiency scores.
(1)’ To obtain input overall technical efficiency of DMU\textsubscript{j}, CCR envelopment problem is solved:

\[ \bar{\theta}_{\text{CCR}} = \text{Min} \theta - \varepsilon \left( \sum_{i=1}^{m} s^-_i + \sum_{r=1}^{s} s^+_r \right) \]

such that \[ \sum_{j=1}^{n} \lambda_j x_{ij} = x_{j0} \theta - s^-_i, \quad i \in M \tag{1.4.1} \]

\[ \sum_{j=1}^{n} \lambda_j y_{rj} = y_{r0} + s^+_r, \quad r \in S \]

\[ \lambda_j \geq 0, \quad j \in N \]

DMU\textsubscript{j} is said to be efficient if and only if \( \bar{\theta}_{\text{CCR}} = 1 \), otherwise DMU\textsubscript{j} is inefficient.

To compute input pure technical efficiency score for DMU\textsubscript{j}, to the problem (1.4.1) we augment the convexity constraint:

\[ \sum_{j=1}^{n} \lambda_j = 1 \tag{1.4.2} \]

(1.4.1) and (1.4.2) constitute the BCC problem. BCC technical efficiency scores are free from returns to scale effects. DMU\textsubscript{j} is said to be efficient if and only if, \[ \bar{\theta}_{\text{BCC}} = 1 \]

(2)’ Input Scale Efficiency scores can be evaluated as follows:

\[ \theta_{\text{SE}} = \frac{\theta_{\text{CCR}}}{\theta_{\text{BCC}}} \tag{1.4.3} \]

(3)’ To explain interbank differences, we implemented Logistic Regression. The dependent variable is binary; the explanatory variables are NPAs, Size of the Bank, and income generated by Off Balance Sheet Business.

The Binary Regression equation is fitted by implementing SPSS.
The most robust bank is such an efficient bank that corresponds,

$$\text{Max } P[y_j = 1/z]$$  \hspace{1cm} (1.4.4)$$

where \( D_0 = \{ j: \theta_{\text{BCC}}(j) = 1 \} \)

Predicted probabilities are calculated for efficient banks.

$$P[y_j = 1/z] = \frac{e^{x_{j}^\theta}}{1 + e^{x_{j}^\theta}}$$  \hspace{1cm} (1.4.5)$$

where \( j \in D_0 \)

For \( j_1, j_2, \in D_0 \), \( P[y_{j_1} = 1/z] \geq P[y_{j_2} = 1/z] \)  \hspace{1cm} (1.4.6)$$

\( \Rightarrow \) DMU_{j_1} is superior to DMU_{j_2}.

Employing Directional Distance functions (DDF) for efficient banks, super efficiency is evaluated solving the following problem:

$$\theta_{\text{Super}}^j = \text{Max } 0$$

such that \( \sum_{j \neq h, j \neq l}^n \lambda_j x_{ij} \leq (1-\theta)x_{ij}, i \in M \)  \hspace{1cm} (1.4.7)$$

$$\sum_{j \neq h, j \neq l}^n \lambda_j y_{ij} \leq (1+\theta)y_{ij}, r \in S$$

$$\sum_{j \neq h, j \neq l}^n \lambda_j = 1$$

$$\lambda_j \geq 0, j \neq j_0$$

Spearman’s rank correlation coefficient can be computed by the formula:
\[ \hat{\rho} = 1 - \frac{\sum_{j=1}^{n} d_{j}^{2}}{n(n^2 - 1)} \]  

(1.4.8)

\( \hat{\rho} \) is calculated for the two sets of scores and the null hypothesis \( H_0: \rho = 1 \) is tested.

(9) For inefficient banks to set efficient input and output targets, Cooper et al., (2007) additive problem is solved for each \( DMU_{0j} \).

\[
\text{Max} \left( \sum_{i=1}^{m} s_{ij}^{-} + \sum_{r=1}^{s} s_{rj}^{+} \right)
\]

such that \( \sum_{j=1}^{n} \lambda_{j} x_{ij} = x_{ijb} - s_{ij}^{-}, \ i \in M \)  

(1.4.9)

\[
\sum_{j=1}^{n} \lambda_{j} y_{rj} = y_{rjb} + s_{rj}^{+}, \ r \in S
\]

\[
\sum_{j=1}^{n} \lambda_{j} = 1
\]

\( \lambda_{j} \geq 0, \ j \in N \)

Input Efficient Targets: \( x_{ij}^{*} = x_{ijb} - s_{ij}^{-}, \ i \in M \)  

(1.4.10)

Output Efficient Targets: \( y_{rj}^{*} = y_{rjb} + s_{rj}^{+}, \ r \in S \)

(10) (i) Cooper et al., (2007) Range Adjusted Measure (RAM) of non-radial efficiency scores are calculated employing optimal slacks of the problem (1.4.9).

\[
\text{RAM}_{0j} = 1 - \frac{1}{m + s} \left[ \sum_{r=1}^{s} \left( \frac{s_{rj}^{+}}{R_{r}} \right) + \sum_{i=1}^{m} \left( \frac{s_{ij}^{-}}{R_{i}} \right) \right]
\]

(1.4.11)

\[ R_{r} = \text{Max} \{ y_{rj} \} - \text{Min} \{ y_{rj} \} \]
\[ R_i = \max_j \{ x_{ij} \} - \min_j \{ x_{ij} \} \]

(ii) Brocket et al., (1997) introduced a measure, expressed as follows:

\[
BRWZ_{10} = \frac{1}{m} \sum_{i=1}^{m} \left( \frac{x_{i0} - s_{i0}^*}{x_{i0}} \right) \times \frac{1}{s} \sum_{j=1}^{s} \left( \frac{y_{ij}}{y_{ij} + s_{ij}^*} \right) \tag{1.4.12}
\]

1.5 CHAPTER SCHEME:

The thesis is divided into five chapters:

- **CHAPTER – I**: INTRODUCTION
- **CHAPTER – II**: REVIEW OF LITERATURE
- **CHAPTER – III**: ANALYTICAL METHODOLOGY
- **CHAPTER – IV**: EMPIRICAL INVESTIGATION
- **CHAPTER – V**: SUMMARY AND CONCLUSIONS.