CHAPTER - 1

Introduction
CHAPTER-I

INTRODUCTION

1.0. INTRODUCTION

There is a variety of methods and techniques for the design of transparent decision process. Multi-criteria Decision Analysis (MCDA) can be used to identify a preferred alternative, to rank the alternatives in decreasing order of preference, or to classify the alternatives into a small number of categories. Although these techniques clearly explain the rank-order positions of the alternatives, they do not always indicate how a particular alternative could reasonably improve its position. This is typically a strong feature of Data Envelopment Analysis (DEA). In principle, DEA is concerned with a number of alternative Decision Making Units (DMU). Each of them is analyzed separately via a mathematical-programming model, which checks whether the DMU under consideration could improve its performance by decreasing its input and increasing its output. The improvement is pursued until the boundary of the convex hull of the other DMU’S is reached. A DMU which cannot improve its performance is efficient or non-dominated. Otherwise, it is dominated by a convex combination of other DMU’S. Thus, the possible improvements for a particular DMU are indicated, not in an arbitrary direction, but on the basis of the performance of the more successful efficient DMU’S.

Data Envelopment Analysis is a linear-programming based technique for measuring the performance efficiency of organizational units which are termed as Decision-Making Units (DMU). This technique aims to measure how efficiently a Decision-Making Unit uses the resources available to generate a set of outputs. This method has been successfully employed for assessing the
relative performance of set of firms that uses a variety of identical inputs to produce a variety of identical outputs.

Generally, the performance of a DMU is assessed with DEA is obtained by using the concept of efficiency which is the ratio of weighted sum of outputs to weighted sum of inputs. Efficiencies obtained by using DEA are relative to the best performance of a virtual DMU. The basic assumption behind the computation of relative efficiency is that if a given firm, A, is capable of producing \( Y(A) \) units of output using \( X(A) \) of inputs, then other firms should also be able to do the same if they operate efficiently.

Data Envelopment Analysis is a methodology based upon an interesting application of linear programming. It was originally developed for performance measurement. It has been employed for assessing the relative performance of a set of firms that uses a variety of identical inputs to produce a variety of identical outputs. DEA involves the use of linear programming methods to construct a non-parametric surface (or frontier) over the data, so as to be able to calculate efficiencies relative to this surface. The principles of DEA date back to Farrell (1957). Cooper et al. (2000) provide recent and comprehensive material on DEA.

Thus, DEA is a mathematical programming technique that finds a number of practical applications to measure the performance of similar units, such as a set of hospitals, a set of schools, a set of banks, a set of industries, etc.

1.1. STATEMENT OF RESEARCH PROBLEM

To start with Indian banking which was dominated by private ownership; profit and return to investments were its performance indicators. This was the scenario prior to 1969. Subsequently, commercial banks were
nationalized adding to their list additional objectives of optimizing social benefit and geographical expansion to meet the growing needs of people. Globalization opened gates to increased competition by the entry of foreign banks. The changes that are taking world wide continued to give shocks to the banking system which resulted in an expansion of banking services both in ranges, volume and non-performing assets. Indian commercial banks have to rise to international standards and evolve suitable competitive strategies.

Gauging efficiency of commercial banks is an important issue to bank management and the policy maker. Before this task is initiated a commercial bank has to be modeled appropriately to the needs and objectives of the analyst.

To model a commercial bank two approaches followed mostly are the intermediation and production approaches. Under the intermediation approach financial institutions are viewed intermediate funds between depositors and borrowers. Banking business has to satisfy both the users and suppliers of bank funds. In production approach a commercial bank’s resources produce services to the customers.

The value added approach and the user cost approach, model a commercial bank differently. According to user cost approach a financial product is an input or output on the basis of its net contribution to bank’s revenue. If returns on a financial product exceeds the opportunity cost then it is treated as output otherwise input. In the name of loan losses, a proxy to NPA, Brackett et al. (1997) included variants of loan losses in both input and output lists. ‘ Provision for loan losses’ appeared in input list, ‘ allowances for loan losses’ in the output list. The later output variable was defined as, valuation reserve – Loan losses. Sueyoshi (2001) attempted to measure financial performance and group the banks using DEA discriminent analysis model. To
measure the risk factor a ratio named as 'Bank Loan Ratio' was used in the discriminant analysis.

Performance of banks and bank branches was studied by a number of analysts, but unfortunately there is no general agreement of choice of technology in terms of inputs and outputs.

The present study models a commercial bank operating on the Indian soil in production approach perspective. The study accommodates non-performing assets as an undesirable output which can serve as input invoking user cost approach. Therefore, this work is a blend of production and user cost approach.

Inputs: 1) Number of employees, 2) Fixed assets, 3) Non-performing Assets

Outputs: 1) Deposits, 2) Loans and advances, 3) Investments.

Adding too many inputs and outputs in the presence of too small a number of decision making units leads to loss of discriminatory power of DEA, since in this case a large proportion of DMUs will surface with 100% efficiency score. Thus, an Analyst shall be objective oriented and parsimonious while inputs and outputs are listed to confront with DEA. The present study considers 51 Public and Private sector banks employing similar inputs to produce similar outputs.

The whole range of inputs employed and outputs produced are accounted by, interest expense and non-interest expense (inputs), interest income and non-interest income (outputs), which explain banking scenario and sufficiently parsimonious to retain discriminatory power of DEA.
Avkiran (2008) attempts to remove the impact of environment with units invariant Data Envelopment Analysis.

1.2. BASIC CONCEPTS

1.2.1. Efficiency Measurement Concepts

The purpose of this section is to outline a number of commonly used efficiency measures and to discuss how they may be calculated relative to an efficiency technology, which is generally represented by some form of frontier function. The frontiers have been estimated with the help of Data Envelopment Analysis and Stochastic Frontiers. These methods involves mathematical programming and econometric methods, respectively.

The modern efficiency measurement begins with Farrell (1957) who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of firm efficiency which could account for multiple inputs. He proposed that the efficiency of a firm consists of two components:

(i) Technical Efficiency (TE), which reflects the ability of a firm to obtain maximum output from a given set of inputs, and (ii) Allocative Efficiency (AE), which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of Total Economic Efficiency.

A) Input – Oriented Measures

Farrell (1957) illustrated his ideas using simple example involving firms which use two inputs \( (x_1, x_2) \) to produce a single output \( (y) \), under the assumption of Constant Returns to Scale. In the following figure, let \( x_s' \) represents isoquant of the fully efficient firm. If the given firm uses quantities of inputs, defined by the points \( P \), to produce a unit of output, then the technical
inefficiency of that firm is represented by the distance $QP$, which is the amount by which all inputs could be proportionally reduced, without a reduction in output. This is usually expressed in percentage terms by the ratio $QP/OP$, which represents the percentage by which all inputs could be reduced.

Then, the technical efficiency of a firm is measured by the ratio, $OQ/OP$

\[ \therefore TE = OQ/OP \]

which is equal to one minus $QP/OP$. Thus, it will take a value between zero and one. Hence, it provides an indicator of the degree of technical inefficiency of the firm. A value of one indicates that the firm is fully technically efficient. The point $Q$ is technically efficient because it lies on the efficient isoquant.

Fig. 1.1
And the price ratio is represented by the line $AA'$. It is useful to calculate allocative efficiency ($AE$) of the firm operating at the point $P$. It is given by

$$AE = OR \cdot OQ$$

since the distance $RQ$ represents the reduction in production costs that would occur if the production were to occur at the allocatively (and technically) efficient point $Q'$, instead of at the technically efficient, but allocatively inefficient point $Q$. Now, the total economic efficiency ($EE$) of the firm is given by

$$EE = OR \cdot OP$$

Here, the distance $RP$ can also be interpreted in terms of cost reduction. And the product of technical efficiency and allocative efficiency provides Overall Technical Efficiency ($OTE$).

$$OTE = TE \times AE = \frac{OQ}{OP} \times \frac{OR}{OQ} = \frac{OR}{OP}$$

This ratio provides overall technical efficiency of a firm. All these input oriented measures are bounded by zero and one.

**B) Output-Oriented Measures**

Let us consider the case where production involves two outputs ($y_1$ and $y_2$) and single input ($x$), under the assumption of constant return to scale. We can represent the technology by a unit production possibility curve in two dimensions. In the following figure, let $zz'$ indicates the unit production possibility curve and the point $A$ corresponds to an inefficient firm. This point
lies below the curve \( z' \) because the curve \( z' \) represents the upper bound of production possibilities.

![Graph](image)

Fig 1.2.

In the above figure, the distance \( AB \) represents technical inefficiency. That is, the amount by which outputs could be increased without requiring extra inputs. Hence, the measure of output-oriented technical efficiency is given by

\[
TE_{oa} = \frac{OA}{OB}
\]

Suppose we have price information then we can draw the iso revenue line \( DD' \), then the allocative efficiency is given by

\[
AE_{oa} = \frac{OB}{OC}
\]
Further, the product of these two measures gives Overall Technical Efficiency, it is given by

\[ OTE_0 = TE_0 \times AE_0 \]

\[ OTE_0 = \frac{OA}{OB} \times \frac{OB}{OC} \]

\[ \therefore OTE_0 = \frac{OA}{OC} \]

further, all of these three measures are bounded by zero and one.

The difference between the input and output-oriented measures can be illustrated using a simple example involving one input and one output. In the following fig(a), we have decreasing return to scale technology represented by \( f(x) \), and an inefficient firm operating at the point \( P \). Then the Farrell input-oriented measure of \( TE \) would be equal to the ratio \( AB/AP \), while the output oriented measure of technical efficiency would be \( CP/CD \).

(a) DRTS

(b) CRTS

Fig 1.3.

Fig 1.4.
The output and input-oriented measures will only provide equivalent measures of technical efficiency when constant return to scale exists. But will be unequal when increasing or decreasing return to scale present. The Constant Return to Scale case is depicted in the above fig(b) where we observe that

\[
\frac{AB}{AP} = \frac{CP}{CD}, \text{ for any inefficient point } P.
\]

1.2.2. Total Factor Productivity

Total Factor Productivity (TFP) is another measure of performance of production unit. It is defined as an index of change in output net of changes in inputs over the same period. A series of TFP growth is calculated over a period of time and suitable index is constructed to get the total factor productivity of a production unit.

Productivity varies due to differences in technology, differences in the efficiency in the production process and the differences in environment in which the production units operate. The usual method of analysis of productivity is based on definition of production function where it is assumed that maximum output is attained at a given level of input.

On the other hand, the efficiency inefficiency of a production unit means the comparison between the observed and the potential output or input. The comparison can take the form of the ratio between observed and optimum level of output for a given input set, the ratio between observed and optimum level of input set for a given level of output, or combination of the two. Generally, the efficiency of production unit can be technical, allocative, scale or economic.

In measuring efficiency a benchmark production function has to be constructed to judge the performance of production units. This efficient
production function is called "Frontier". Isocost and Isoquant lines are used to
describe to production behaviour of individual firm.

1.2.3. Trans Log Form of Distance Function

Input distance function may be defined as,

\[
\ln D(u,x) = \alpha_u + \sum_{i=1}^{s} \alpha_i \ln x_i + \sum_{j=1}^{r} \beta_j \ln u_j + \frac{1}{2} \sum_{i=1}^{s} \sum_{j=1}^{r} \alpha_{ij} \ln x_i \ln x_j + \frac{1}{2} \sum_{i=1}^{s} \sum_{j=1}^{r} \beta_{ij} (\ln u_i)(\ln u_j) + \frac{1}{2} \sum_{i=1}^{s} \sum_{j=1}^{r} \gamma_{ij} \ln x_i \ln u_j \quad \ldots (1.2.1)
\]

Where \( v \sim N(0, \sigma^2) \)

Output distance function may be defined as,

\[
\ln D_o(x,u) = \beta_o + \sum_{i=1}^{s} \beta_i \ln x_i + \frac{1}{2} \sum_{i=1}^{s} \sum_{j=1}^{r} \beta_{ij} \ln x_i \ln x_j + \sum_{j=1}^{r} \alpha_j \ln u_j \\
+ \frac{1}{2} \sum_{i=1}^{s} \sum_{j=1}^{r} \alpha_{ij} \ln u_i \ln u_j + \frac{1}{2} \sum_{i=1}^{s} \sum_{j=1}^{r} \gamma_{ij} \ln x_i \ln u_j
\]

1.3. COLLECTION OF DATA

This study uses secondary data, collected from the Reserve Bank of India Bulletins (2007). The translog input distance function that accommodates multiple inputs to produce multiple outputs is proposed to be fitted. Since the user cost approach identifies NPA as an input, upon estimating the distance function it will examined the relationship between inputs if they are substitutes or complements. The method of estimation is maximum likelihood so that the statistical estimates of parameters possess standard errors and hence t-values.
1.4. OBJECTIVES OF THE PRESENT STUDY

The main aim of the present research study is to measure the efficiency of the Indian commercial banks by using the Translog Input/output Distance Function.

The specific objective of the study are:

i) to estimate translog input output distance function by the method of maximum likelihood;

ii) to set up input targets for inefficient commercial banks;

iii) to examine substitutability or complementarity’s between employees; fixed assets and non-performing assets and;

iv) to compute scale elasticity for each of the commercial banks.

1.5. CHAPTER SCHEME

The contents of the present study have been presented under the following heads:

1. Chapter I : Introduction

2. Chapter II : Review of the Literature

3. Chapter III : Theory and Methodology

4. Chapter IV : Empirical Investigation

5. Chapter V : Summary and Conclusions.