Chapter - I

INTRODUCTION
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1.1 The earliest contribution to measure efficiency of production was due to Farrell M.J*. The method proposed was empirical and it could handle two inputs and one output. The production efficiency assessed was relative rather than absolute. To estimate the efficiency of a production unit, its input per unit output are compared with a relevant input per unit output point on the isoquant of unit output. The method assumes that each production unit is input scale efficient.

The work of Farrell was extended by Charnes, Cooper and Rhodes** (1978) who postulated a fractional programming problem which was later converted into a linear programming problem by applying Charnes - Cooper transformation. The method could handle multiple inputs and multiple outputs with comfortable ease. Like Farrell’s approach the CCR (1978) formulation assumes all the production units enjoy constant returns to scale. This model was extended to accommodate variable returns to scale by Banker, Charnes and Cooper *** (BCC 1984). The dual of BCC (1984) problem was called as envelopment problem, hence the name Data Envelopment Analysis (DEA).

To measure efficiency of production units several approaches were thought of by different researchers. The CCR (1978) and BCC (1984) formulations ask for radial expansion of outputs or radial contraction of inputs to attain 100 percent efficiency score. The input contraction or output expansion does not seek change in either input mix or output mix, which means no change in the technique of production and that is how the name ‘technical efficiency’ arose.

Fare et.al**** (1996) developed a non-radial method of efficiency measurement, that seeks simultaneously expansion of outputs and contraction of

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inputs. The production possible set was bound by piece wise linear production frontier. The input and output vectors of an inefficient production unit were projected on to the production frontier, the path of projection was a parabola. The programming method formulated was non-linear, that was transformed into a linear programming problem by Taylor’s expansion of a non-linear function.

Fare et al *(1994)* formulated a non-radial method that different inputs were contracted at different rates and different outputs were expanded at different rates. The method was known as Russell’s non-radial method of efficiency measurement.

Tone **(2001)** developed slack based method of efficiency measurement which maximized the sum of inputs and outputs slacks. The efficiency measure was known as slack based efficiency measure.

Fare et. al ****(1996)* formulated directional distance functions to measure efficiencies of production units. The concept ‘distance function’ was due to Shephard R.W ****(1970)*. His distance functions are inversely related to Farrell’s efficiency measures. The distance function related to input efficiency measurement was known as input distance function and the one related to output efficiency measurement was called as output distance function. Its returns to scale are constant, it can be shown that the Shephard’s input distance function is inverse of the output distance function. Such a relationship does not exist if returns to scale are non-constant. The BCC (1984) formulation leads to multiplicative decomposition of CCR (1978) overall technical efficiency measure into pure technical and scale efficiencies. In radial efficiency measurement the measure lies between 0 and 1. For example, an input technical efficiency of 0.80 means the production unit that attained this efficiency score could have used 80 percent of its current inputs to produce outputs that it is producing currently.

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*** Fare et. Al (1996), op. cit.

The study proposed aims at examining profit efficiency of commercial banks. These banks constitute central, nervous system of Indian economy. Prior to nationalization the commercial banks of India were highly protected industry. Its only goal was profit maximization. Post nationalization the commercial banks were assigned to meet social objectives also, in addition to profit maximization. The banking industry in India is a net work of public, private and foreign sector banks.

The objectives of the study are,

i. To evaluate potential profit of each commercial bank

ii. To rank them according to their profit efficiency

iii. To decompose additively the profit efficiency score into directional pure technical, risk and allocative efficiency.

With every transaction of a commercial bank an element of risk is associated. The assets of a commercial bank are classified into 1. standard assets, 2. substandard assets 3. doubtful assets and 4. loss assets. The last three types of assets constitute non-performing assets (NPA). NPA are mill stone round the neck of a commercial bank. One of the very important determinants of bank failure is NPA. NPA reflects the risky environment of commercial banks. The management of a bank, combining its inputs, can produce desirable and undesirable outputs. Both the types of outputs coexist. Shephard, R.W * (1970) introduced two concepts viz., free disposability and weak disposability of inputs and outputs. Weak disposability implies for a given input vector outputs can be proportionally reduced to stay on the output level set. Fare et.al**(2004) formulated a null joint hypothesis which conveyed that reduction of bad outputs to zero level is possible only by terminating production. The weak disposability and null joint hypotheses can be jointly imposed on the production possibility set of BCC (1984) formulation.

1.2 Inputs and outputs of Data Envelopment Analysis:

The first step in Data Envelopment Analysis (DEA) is selection of inputs and outputs. While these are selected certain degree of parsimony should be exercised.

Otherwise, inclusion of too many inputs and outputs leads to loss of discriminatory power of DEA, since several banks will surface with 100 percent efficiency score. Never the less the selection of inputs and outputs should meet the objectives of the analyst.

Before DEA models are implemented to measure efficiency of decision making units, each DMU has to be suitably modeled. There are three popular approaches to model a commercial bank in the perspective of production approach or intermediation approach or the user cost approach. The production approach considers that banks use capital, labour and other non-financial inputs to provide the outputs, viz., deposits, advances and services for account holders. Inputs and outputs employed in production approach are mostly stock variables. In the intermediation approach banks intermediate funds between savers and investors. The intermediation approach has several variants. Berger and Humphrey (1991, 1993) considered the activities for which banks create high value added such as loans, demand deposits and saving deposits as important outputs; labour, capital and purchased funds are treated as inputs. This is known as value added approach. In ‘user cost’ frame work a bank asset is classified as an output if the financial return on the asset exceeds the opportunity cost of the investment, and a liability is classified as an input if the financial cost of liability is less than its opportunity cost. Though the value added and user cost approaches differ in their details, empirically they resort to the same classification of inputs and outputs.

Wheelock, Wilson (1995) adopted intermediation approach for which inputs are labour, physical capital and purchased funds. Outputs are real estate loans, commercial and industrial loans, consumer loans and other loans and total demand deposits.

Milind Sathye (2003) postulated two DEA models, where in model A, to measure efficiency as directly as possible, two input and two output variables are considered. Net interest income and non-interest income are outputs; interest expense

and non-interest expenses are the inputs. Another DEA model postulated with deposits and employees as inputs and net loans and non-interest income as outputs. Between the two models deposits replace interest expense; employees replace non-interest expenses and net loans become proxy for net interest income.

DEA is sensitive to the choice of input and output variables. This is a strength of the technique, since it reveals which of the input and output variables are closely monitored by bank management to control efficiency.

1.3 DATA:

This study considers two inputs and three outputs capable of including most of the bank transactions.

DEA inputs are, interest income and other income; and DEA outputs are, interest expenditure, other operating expenses. Sum of output variables lead to income, on the other hand, sum of the input variables lead to expenditure. The difference between income and expenditure leads to net profit.

The data used in the study are collected from Reserve Bank of India Bulletins (2009-2010).

We can arrive at the following inequalities:

\[
\tilde{D}_{\alpha 1}(x, u, n, g, y, x) \leq \tilde{D}_{\alpha 1}(v, u, n, g, y, x) \leq \tilde{D}_{\alpha 1}(x, u, n, g, y, x) \leq \frac{\pi(p, w) - (p_{x0} + w_y)}{p_{x0} + w_y}.
\]

This inequality leads to the definitions of profit efficiency indicator, allocative efficiency indicator, overall directions distance efficiency indicator, exogenous risk efficiency indicator and endogenous risk efficiency indicator.

\[\text{Figure (1.3.1)}\]
The profit efficiency indicator can be decomposed additively into allocative efficiency, exogenous risk efficiency, endogenous risk efficiency and

\[
\frac{\pi(p,w)-(pw_0-wx_0)}{pg_u+wg_z} = \left[ \frac{\pi(p,w)-(pw_0-wx_0)}{pg_u+wg_z} \cdot \overline{D}_{\alpha(c)}(x_0,u_0;g_z,g_s) \right] + \left[ \overline{D}_{\alpha(c)}(x_0,u_0;g_z,g_s) - \overline{D}_{\alpha(c)}(x_0,u_0,u_0;g_z,g_s) \right] + \left[ \overline{D}_{\alpha(c)}(x_0,u_0;g_z,g_s) - \overline{D}_{\alpha(c)}(x_0,u_0;g_z,g_s) \right] + \overline{D}_{\alpha(c)}(x_0,u_0;g_z,g_s)
\]

\[
= \overline{AE} + EXO.E + ENDO.E + \overline{D}_{\alpha(c)}(x_0,u_0;g_z,g_s)
\]

where \( \overline{AE} \) is directional allocative efficiency;

\( EXO.E \) is directional exogenous risk efficiency;

\( ENDO.E \) is directional endogenous risk efficiency;

\( \overline{D}_{\alpha(c)}(x_0,u_0;g_z,g_s) \) is the directional distance function, which measures directional technical efficiency.

For directional efficiency to hold, the corresponding directional efficiency score should be equal to zero.

Directional efficiency measurement is subjective. The efficiency depends upon the direction in which inputs are reduced and outputs are increased.

Two particular cases are followed frequently,

a) \((g_z,g_s) = (1,1)\)

b) \((g_z,g_s) = (g_{x_0},g_{x_0}) = (x_0,u_0)\)

The later realization relates directional efficiency measures with the popular input and output radial measures.

\[
\overline{D}_{\alpha}(x_0,u_0;g_z,g_s) = \max \{ \theta : (x_0 - \theta g_z, u_0 + \theta g_s) \in G \}
\]
By letting \( g_x = 0 \) and \( g_u = u_o \), we obtain

\[
\overline{D}_o(x_o, u_o; 0, u_o) = \max \{ \theta : (x_o, u_o + \theta u_o) \in G \}
\]

\[
= \max \{ \theta : \sum_{j=1}^{s} \lambda_j x_j \leq x_{i_0}, \sum_{j=1}^{s} \lambda_j u_j \geq u_0 + \theta u_0 \}
\]

\[
= \max \{ \theta : \sum_{j=1}^{s} \lambda_j x_j \leq x_{i_0}, \sum_{j=1}^{s} \lambda_j u_j \geq (1 + \theta) u_0 \}
\]

\[
= \max \left\{ (1 + \theta)^{-1} : \sum_{j=1}^{s} \lambda_j x_j \leq x_{i_0}, \sum_{j=1}^{s} \lambda_j u_j \geq (1 + \theta) u_0 \right\} - 1
\]

\[
= \left[ D_o(x_o, u_o) \right]^{-1} - 1
\]

\[
\overline{D}_o(x_o, u_o; 0, u_o) = \frac{1}{D_o(x_o, u_o)} - 1
\]

By letting \( g_x = x_o \) and \( g_u = 0 \), we obtain

\[
\overline{D}_o(x_o, u_o; x_o, 0) = 1 - \frac{1}{D_i(u_o, x_o)}
\]

where

\[
D_o(x_o, u_o) = \left[ \max \{ \beta : (x_o, \beta u_o) \in G \} \right]^{-1}
\]

\[
D_i(u_o, x_o) = \left[ \min \{ \lambda : (\lambda x_o, u_o) \in G \} \right]^{-1}
\]

are output and input distance functions.

1.4 THE THESIS IS DIVIDED INTO FIVE CHAPTERS:

CHAPTER – I : INTRODUCTION
CHAPTER – II : REVIEW OF LITERATURE
CHAPTER – III : THEORY AND METHODOLOGY
CHAPTER – IV : EMPIRICAL INVESTIGATION
CHAPTER – V : SUMMARY AND CONCLUSIONS