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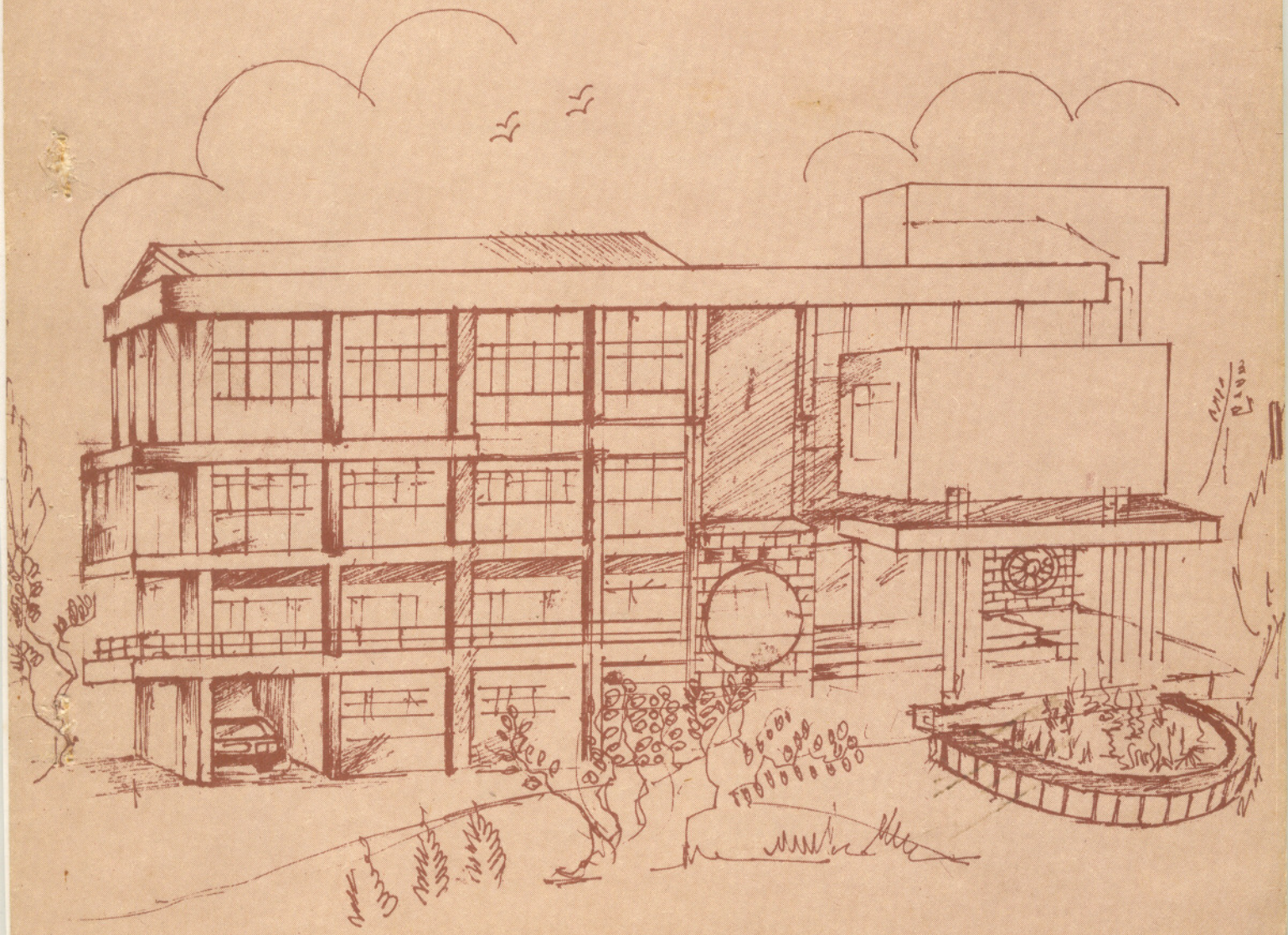
Efficiencies and Returns to Scale in Life Insurance Corporation of India Using Data Envelopment Analysis



Efficiencies and Returns to Scale in Life Insurance Corporation of India Using Data Envelopment Analysis

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Efficiencies and Returns to Scale in Life Insurance Corporation of India Using Data Envelopment Analysis

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Abstract: This paper applies the technique of data envelopment analysis to measure the eight efficiency concepts and, scale economies (SE) and returns to scale (RTS) of Indian Life Insurance Corporation (LIC) of India before and after liberalization. This study finds that LIC has maintained hign SE and increasing RTS in the operation of periods (1983-1995) and decreasing returns to scale in the operations of last four years (1996-1999). This study finally concludes that Indian LIC lost its monopoly status in exploiting scale economies as a result of liberalization.

Key Words: LIC; DEA; Returns to Scale; Scale Economies

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1. Introduction

Life Insurance Corporation (LIC) of India was formed in September in 1956 with a capital contribution of Rs.5 crores from Government of India. LIC is the only insurance company operating in the life insurance sector in India for the last 43 years. For the year 1998-99 LIC had Rs.75606.26 crores in assurances and Rs. 13.08 crores in annuities. The number of policies in assurance is 148.57 lakhs and in annuities is 0.06 lakhs. The annual premium in assurance is Rs.4880.52 crores and in annuities 4.93 crores. Insurance penetration in 1997 is 1.39% compared to 9.42% in Japan according to Swiss Reinsurance Company (1999). Insurance density in 1997 is 5.4$ compared to 3092$ in Japan. Even though LIC in India enjoyed monopoly status, the above figures raise questions on the efficiency/productivity status of LIC. We therefore study the LIC's performance over the past 17 years covering both prior and post financial liberalization.

In insurance sector, multiple outputs are produced using multiple inputs. These inputs and outputs are denominated in non-homogeneous units. Traditional single-factor (e.g., labor productivity or capital productivity) may be used in these circumstances to produce a set of *ad hoc* productivity measures. Yet there is no reason *a priori* that these single-factor ratios should yield a consistent summary view of performance. A summary total-factor measure of performance avoids the ambiguity of single-factor ratios, but requires the aggregation of inputs and outputs. Data Envelopment Analysis (DEA) (Charnes *et al.* (1978)) embodies the principle of total-factor view of efficiency, and in addition, provides a system of weights allowing the reduction of multiple ratios into a scalar overall view of performance.

Currently, there are a number of approaches to production frontier estimation, which is used to evaluate productive performance, and the most frequently used methods are DEA and econometric methods. Each of these approaches is consistent with the estimation of production or cost function as a boundary function. In the past productive performance has often been couched in terms of the *average* standard embodied in *least squares* cost and productions. This is unsatisfactory as far as a performance norm based on average practice may allow the persistence of inefficiency. The full gains from improved productivity are only available on the boundary of the production possibility set. Any less demanding norm will tend to legitimize some degree of inefficiency and is inconsistent with the economic theory of production. Based on the observed best practice, DEA, in principle, is consistent with the more demanding standards set by boundary production.

While the literature that addresses the returns to scale and efficiency is relatively abundant, the research on using DEA/frontier production method to evaluate these productive performance in insurance sector is quite sparse and fairly recent. The recent applications of DEA models on insurance sector include works on the efficiency of organizational forms and distribution systems of the US property and liability insurance industry by Brocket *et al.* (1998) and Cummins *et al.* (1999). However, the application of DEA on Indian insurance sector in India is nil. Financial liberalization in Indian economy started in 1991. Malhotra (1994) finds that LIC is a monolith and recommended liberalization in insurance. Banerjee (2000) founded that effectiveness of insurance penetration and insurance density is low. The Insurance Regulatory and Development Authority Bill, 2000 has been passed and the insurance sector has been opened up. In the light of above mentioned fact, this paper aims at measuring the estimates of returns to scale and various measures of efficiency using DEA. The study uses the aggregate time-series data on Indian life insurance sector from 1982-83 to 1998-99 for the aforementioned purpose.

The structure of the paper is as follows: Section 2 discusses some DEA models for production and cost analyses. Section 3 describes the relationship among DEA results, underlying efficiency concepts, SE, and RTS from the perspective of production and cost performance. The data set regarding LIC operations is discussed in Section 4. Section 5 deals with results and discussion and finally the summary of the work is presented in the last section.

2. DEA Models

For production analysis

Following Seiford and Thrall (1990), Sueyoshi (1997) formulated the following generalized LP model:

$$\min \ \theta$$
$$s.t. -\sum_{j=1}^{n} X_j \lambda_j + \theta X_k \geq 0,$$
$$\sum_{j=1}^{n} Y_j \lambda_j \geq Y_k,$$
$$L \leq \sum_{j=1}^{n} \lambda_j \leq U,$$
$$\lambda_j \geq 0, \theta : free \ , j = 1,2,...., n \qquad .....(1)$$

where the sum of λ_j is restricted by its upper ($U \geq 1$) and lower ($0 \leq L \leq 1$) bounds.

Here, Y_j is an $s \ x \ n$ matrix of observed outputs, X_j is an $m \ x \ n$ matrix of observed inputs, λ_j is an $n \ x \ 1$ vector of weights, and X_k and Y_k are the respective input and output vectors for the DMU of interest. One might note that each model constraint defines an input or output dimension, which each column in the input and output matrices associated with λ defines the performance of a DMU.

The objective function (1) minimizes the contraction factor, θ, which is applied to all inputs of DMU_k. The first constraint states that the contracted input levels of DMU_k will be greater than or equal to the input levels at the frontier. The second constraint assures that the output levels of DMU_k will be less than or equal to the output levels at the frontier. At the optimum, θ will be a measure of DMU_k's distance from the 'best practice' frontier. In addition, only those DMUs defining that particular facet of the frontier, which intersects with the radial path of DMU_k input contraction, will have non-zero λ values; all other λ's will be equal to zero. DMUs with non-zero λ values, then, are the perfectly efficient DMUs, which serve as the 'best practice comparators' for DMU_k.

The dual form of (1) becomes

$$\max WY_k + \sigma_1 L - \sigma_2 U$$
$$s.t. -VX_j + WY_j + \sigma_1 - \sigma_2 \leq 0, j = 1,2,...., n,$$
$$VX_k = 1,$$
$$V \geq 0, U \geq 0, \sigma_1 \geq 0, and \, \sigma_2 \geq 0. \qquad .....(2)$$

Here V and W are two row vectors of dual variables related to the first and second sets of constraints of model (1). And, σ_1 and σ_2 are all dual variables derived from the last constraint of (1). Changing L and U model (1) many different DEA models as follows:

- When $L = 0$ and $U = \infty$, equation (1) becomes CCR model where the assumption of CRS is assumed and the objective function value θ measures 'technical and scale' efficiency of DMU_k (Charnes *et al.* (1978)).

- When $L = 1$ and $U = 1$, equation (1) becomes BCC model where the assumption of VRS is maintained and the objective function value θ measures purely 'technical' efficiency of DMU_k (Banker *et al.* (1984)).
- When $L = 0$ and $U = 1$, the model is Hybrid Model (Increasing returns to Scale).
- When $L = 1$ and $U = \infty$, the model is Hybrid Model (Decreasing Returns to Scale)

Model (1) represents an input-oriented DEA structure. An output-oriented DEA model can be formulated by changing both the location of θ from X_k to Y_k in (1) and the objective of (1) from minimization to maximization. The incorporation of the constraint $\Sigma \lambda_j$ in (4) and its related dual variables (σ_1, σ_2) in (2) provide empirical information on the concept of RTS. See Banker and Thrall (1992) and Banker *et al.* (1984) for a detailed discussion on the relationship between $\Sigma \lambda_j$ and RTS.

The multipliers, μ_r and v_i are treated as unknown variables in model (2). Therefore, each DMU may select any multipliers for its inputs and outputs, given an assumption that they are nonnegative. However, this methodological feature becomes a source of serious shortcoming when some kind of prior information on prices is available to a DEA user. DEA, for example, may yield zeros in multipliers, indicating that these corresponding inputs and/or outputs are not used for determining the efficiency level of a DMU. The original CCR ratio form incorporates a non-Archimedean small number in CCR model so as to exclude zero weights in the manner that all the inputs and outputs are fully utilized to determine the DEA efficiency score. However, it is almost impossible to select the best non-Archimedean small number. Different numbers produce different DEA results. In order to overcome this shortcoming, new approaches such as "Assurance Region" (Thompson *et al.* (1986, 1990), Sueyoshi (1992)) and "Cone Ratio" (Charnes *et al.* (1989, 1990) were found in the literature.

Cost Analysis

In the model, given the positive input price vector, the minimized cost of specific *k*th DMU is measured by the following DEA model:

$$\min \; P_k X$$

$$s.t. -\sum_{j=1}^{n} X_j \lambda_j + X \geq 0,$$

$$\sum_{j=1}^{n} Y_j \lambda_j \geq Y_k,$$

$$L \leq \sum_{j=1}^{n} \lambda_j \leq U,$$

$$X \geq 0, \lambda_j \geq 0, j = 1,2,\ldots, n \qquad \ldots\ldots(3)$$

where the vector $X = (x_1, x_2, \ldots\ldots, x_m)^T$ represents a vector of decision variables regarding input quantities. This model yields optimal X^*, minimizing the total cost c_k^* ($=P_kX^*$). So the cost efficiency of *k*th DMU is

$$OE_k = c_k^*/c_k = P_kX^*/P_kX_k \qquad \text{.....(4)}$$

The dual of model (3) can be written as

$$\begin{aligned} &\max WY_k + \sigma_1 L - \sigma_2 U \\ &s.t. -VX_j + WY_j + \sigma_1 - \sigma_2 \le 0, j = 1,2,....,n, \\ &V \le P_k, \\ &V \ge 0, U \ge 0, \sigma_1 \ge 0, and \sigma_2 \ge 0. \end{aligned} \qquad \text{.....(5)}$$

At the optimum, $P_kX^* = W^*Y_k + \sigma_1^* L - \sigma_2^* U$.

As pointed out by Sueyoshi (1997), the models (3) and (5) can be considered as special forms of the AR and CR DEA models where the availability of the reasonable price vector enters as input weight in the general DEA model. The importance of (3) and (5) is that the two DEA models make it possible to connect DEA to important economic concepts such as efficiency concepts, scale economies and returns to scale.

3. Efficiency Concepts and Returns to Scale

The principle of duality says that given any production technology, it is straightforward to derive a cost function. Or, given a cost function one can derive a production technology that could have generated that cost function. This means that the cost function contains essentially the same information that production technology contains. Sueyoshi (1997) demonstrates how DEA-based cost attributes are related to production technology and various concepts of efficiency that are characterized by a production possibility set (T) and an input requirement set (A). The structure of production technology is defined in the literature as the set of all feasible input and output vectors, i.e. more technically, T = {(X, Y): Y can be produced from X}. Banker and Thrall (1992) redefined T in terms of DEA framework as follows:

$$T = \left\{ (X,Y): X \ge \sum_{j=1}^{n} \lambda_j X_j, Y \le \sum_{j=1}^{n} \lambda_j Y_j, L \le \sum_{j=1}^{n} \lambda_j \le U, \lambda_j \ge 0 \right\} \qquad \text{.....(6)}$$

and the input requirement set, which is a subset of T, is defined as

$$A = \{X : (X,Y) \in T, PX \ge C(Y,P)\} \qquad \text{.....(7)}$$

This input set gives precisely input quantities from which it is possible to produce Y at least as expensive as the cost-minimum C (Y, P).

3.1 Eight Different Concepts of Efficiency

1. Overall Efficiency (OE): The OE of DMU_k is measured from (4) after setting (L, U) = (1, 1) in (3).

2. Overall and Scale Efficiency (OSE): The OSE of DMU_k is obtained from (4) after setting (L, U) = (0, ∞) in (3).
3. Cost-Scale Efficiency (CSE): The CSE of DMU_k is measured by CSE = OSE / OE.
4. Technical Efficiency (TE): The TE of DMU_k is measured by (1) after setting (L, U) = (1, 1).
5. Technical and Scale Efficiency (TSE): The TSE of DMU_k is obtained from (1) after setting (L, U) = (0, ∞).
6. Production-Scale Efficiency (PSE): The PSE of DMU_k is measured by PSE = TSE / TE.
7. Allocative Efficiency (AE): The AE of DMU_k is measured by AE = OE / TE.
8. Allocative and Scale Efficiency (ASE): The ASE of DMU_k is measured by ASE = OSE / TSE

Figure 1 depicts the conceptual differences among the eight efficiency measures.

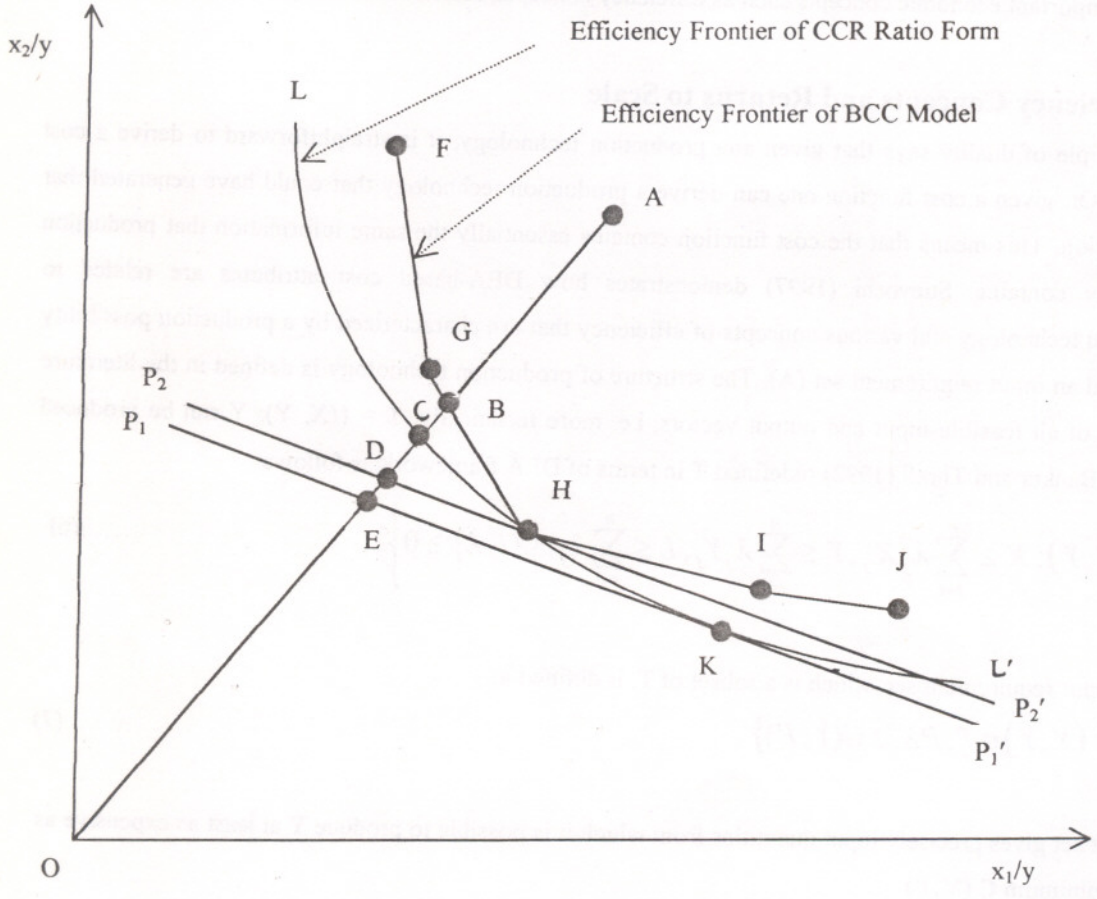

Figure 1: Visual Description of Eight Efficiency Concepts

There are six DMUs (A, F, G, H, I and J) in this figure, each uses two inputs (x_1, x_2) to produce one output (y) where all the output and inputs are positive. The two coordinates represent standardized inputs. This figure depicts both CCR (determined by setting L=0 and U=∞) and BCC (determined by setting L=U=1) frontiers based on the assumption of CRS and VRS respectively.

Description of TE, OE and AE:

In the Figure 1, let us measure the efficiency of DMU A. TE of DMU under VRS is defined as OB/OA. Given the price vector P, DMU H is identified as a cost-minimizing point. A supporting hyperplane denoted by the line P_2-P_2' passes through H located on the efficient frontier (F-G-H-I-J). The point D can substitute for H, because both are on the same supporting hyperplane of P and therefore cost on D equals that of H. Thus the OE is measured by OD/OA. Hence, AE is defined as OE/TE (=OD/OB = (OD/OA)/(OB/OA)). Here the AE measure represents the level as to how an organization effectively manages its input/output mixes in the light of prevailing market input-price. These three efficiency concepts (TE, OE and AE) proposed by Farrell (1957) are solved by DEA models (4) and (6) with L=U= 1.

Description of TSE, OSE and ASE:

The efficiency concepts such as TSE, OSE and ASE differ from the earlier three efficiency concepts in that only the term scale is added because these are developed under the assumption of CRS. The line L-L′ depicts the CCR efficiency frontier (L = 0 and U = ∞) where the assumption of CRS holds good and the line P_1-P_1' depicts a supporting hyperplane passing through the point K, which is a cost-minimizing point to the DMU A in Figure 1. Following the descriptions of TE, OE and AE, these three efficiency concepts are visualized by TSE = OC/OA, OSE = OE/OA, and ASE = OSE/TSE = OE/OC respectively. TSE, OSE and ASE are solved by DEA models (4) and (6) with L = 0 and U = ∞.

Description of PSE and CSE:

Following the research of Banker *et al.* (1984) and Banker and Thrall (1992), the PSE, widely known as 'radial scale efficiency', is defined as TSE/TE (=OC/OB). The degree of PSE indicates the level of change in TE due to the incorporation of CRS. However, Sueyoshi (1997), for the first time, defines CSE as OSE/OE, which is visualized measured by OE/OD [= (OE/OA)/(OD/OA)] in Figure 1. This indicates the level of change in OE due to the incorporation of CRS.

The CSE measure of DMU_k through model (8) can be expressed as CSE = $(W^*Y_k)/(W^*Y_k + \sigma_1^* - \sigma_2^*)$, where W^*Y_k and $W^*Y_k + \sigma_1^* - \sigma_2^*$ represent the minimum cost of DMU_k assuming technology exhibiting CRS and VRS respectively. When $\sigma_1^* - \sigma_2^* = 0$, the CSE equals one, indicating that DMU_k operates under CRS. Thus, measuring CSE enables one to examine whether a DMU exhibits CRS. However, this CSE examination cannot determine the degree of RTS.

3.2 Scale Economies and Returns to Scale

The study of Sueyoshi (1997) is the first one, which links returns to scale with scale economies in the DEA literature. Baumol *et al.* (1982) defines the degree of scale economies ($\in$) in the case of a single output (y) as AC/MC where AC (= c(y) / y) and MC (= dc(y) / dy) represent average cost and marginal cost respectively. Here, d indicates derivative of a function. Examination of $\in$ leads to the following classification of RTS:

(i) Increasing Returns to Scale (IRS) $\leftrightarrow \in > 1$,

(ii) Constant Returns to Scale (CRS) $\leftrightarrow \in = 1$, and

(iii) Decreasing Returns to Scale (DRS) $\leftrightarrow \in < 1$.

In the multiple output case, letting X* be he optimal solution to model (3) and W*, σ_1* and σ_2* be the optimal solutions to model (5), the relationship $c_k^* = P_kX^* = W^*Y_k + \sigma_1^*L - \sigma_2^*U$ holds good for each DMU_k at the optimal solution. Further, $c = W^*Y + \sigma_1^*L - \sigma_2^*U$ is a supporting hyperplane to the input requirement set, A at (c_k, Y_k). The slope of the hyperplane is found out by differentiating c with respect to y as:

$$(\partial c/\partial y_1, \partial c/\partial y_2, \ldots\ldots, \partial c/\partial y_s) = W^* = (w_1^*, w_2^*, \ldots\ldots, w_s^*) \qquad \ldots\ldots(8)$$

Following Baumol *et al.* (1982), the degree of scale economies (DSE) at (c_k, Y_k) is defined as

$$DSE_k = c_k^{\bullet} / \left(\sum_{r=1}^{s} \frac{\partial c_k^{\bullet}}{\partial y_{rk}} . y_{rk} \right) \qquad \ldots\ldots(9)$$

By incorporating (11) into (12), the degree of scale economies becomes

$$DSE_k = c_k^{\bullet} / \left(\sum_{r=1}^{s} w_r^{\bullet} . y_{rk} \right) = c_k^{\bullet} / W^{\bullet} Y_k \qquad \ldots\ldots(10)$$

The right hand side of (10) indicates the ratio of average cost to marginal cost in the multiple output case. Therefore, (13) can be used as a measure of RTS. Using equation (10), the RTS classification is as follows:

$$\text{IRS} \leftrightarrow DSE_k > 1, \text{ CRS} \leftrightarrow DSE_k = 1, \text{ and DRS} \leftrightarrow DSE_k < 1.$$

Since at the optimum, $c_k^* = W^*Y_k + \sigma_1^*L - \sigma_2^*U$ in (5), (10) can be writen as

$$DSE_k = c_k^*/[\, c_k^* - \sigma_1^*L - \sigma_2^*U] = 1/(1 - \zeta). \qquad \ldots\ldots(11)$$

Here, $\zeta = (\sigma_1^*L - \sigma_2^*U)/\, c_k^*$. The value of ζ is always less than or equal to 1.

Assuming that an optimal solution is uniquely determined, i.e. there is no problem of degeneracy, Sueyoshi (1997) classifies the RTS of *k*th DMU by the following equivalent statements of Proposition 1:

(i) IRS ($DSE_k > 1$) if and only if $0 < \zeta < 1$ and $\sigma_1^* > 0$.

(ii) CRS ($DSE_k = 1$) if and only if $\zeta = 0$ and $\sigma_1^* = \sigma_2^* = 0$.

(iii) DRS ($DSE_k < 1$) if and only if $\zeta < 0$ and $\sigma_2^* > 0$.

The degree of scale economies cannot be uniquely determined at (c_k, Y_k) only when there is problem of degeneracy in (3) (or (5)), i.e. there are multiple supporting hyperplanes. The upper and lower bounds of ζ need to be identified so that one can identify the upper and lower bounds of RTS. In this case, Sueyoshi (1997) proposed the following LP model:

$$\begin{aligned}
&\max \sigma_1 L - \sigma_2 U \\
&s.t. -VX_j + WY_j + \sigma_1 - \sigma_2 \le 0, j = 1,2,....,n, \\
&V \le P_k, \\
&WY_k = c_k^*, \\
&V \ge 0, U \ge 0, \sigma_1 \ge 0, and \sigma_2 \ge 0.
\end{aligned} \qquad \text{.....(12)}$$

The upper bound of ζ is determined by $\zeta = (\sigma_1^* L - \sigma_2^* U)/ c_k^*$. The lower bound of ζ can be obtained by changing the objective of (12) from maximization to minimization. The upper and lower bounds of ζ determines the level of RTS as given in Proposition 1.

It is to be noted here that in all the above analysis it has been maintained that if production technology exhibits IRS, then the cost function exhibits declining average cost curve, i.e. economies of scale operate. However, cost of production is a more general concept to include those savings in cost arising from sources like bulk buying at preferential lower prices, lower transport cost, lower advertising cost and other selling cost, etc., all of which have nothing to do with the production unit. Cost savings of this kind, if they exist, would also reduce the overall average cost as output expands, and they should be recognized as scale effects. Thus, these two concepts, returns to scale and economies of scale, have distinctive causative factors that do not permit them to be used interchangeably. A description concerning the theoretical differences between returns to scale and economies of scale lies beyond the scope of our study. See, for example, the study of Sahoo *et al.* (1999) in which both the concepts are critically analyzed and distinguished in the context of classical and neo-classical perspective.

4. The Data Set Regarding LIC Operations

Measuring Outputs, Inputs and Input Prices

A modified version of the value added approach to measure life insurance output is adopted in our study. The value added approach counts as important outputs those that are significant value added, as judged using operating cost allocations (Berger and Humphrey, 1992). We follow the recent insurance efficiency literature in defining insurance output as the present value of real losses incurred (e.g. Cummins and Weiss, 1993, Berger *et al.*, 1997). We have taken losses as the claims settled during the year including claims written back (y_1). The rationale for the use of losses to proxy for insurance output is that the primary function of insurance is risk pooling, i.e. the collection of funds from the policyholder pool and the redistribution of funds to those pool members who incur losses (Cummins, Weiss and Zi, 1999). Losses are deflated to the base 1995 using the Consumer Price Index (CPI). The CPI data is taken from *International Financial Statistics Year Book* (1999).

Following the study of Brockett *et al.* (1998), the ratio of liquid assets to liabilities (y_2) is taken as the second output in our study. Liquid assets have taken as the sum of outstanding Premiums, Interest, Dividends and rents outstanding; interest, dividends and rents accruing but not due; deposits with banks; cash and bank balance and remittances in transit. Liabilities are the probable future sacrifices of economic benefits stemming from present legal, equitable, or constructive obligations to transfer assets or to provide services to other entities in the future as a result of past events affecting the corporation. This ratio reflects a company's claims-paying ability; this is an important objective of an insurer firm, with improvement in claims-paying ability contributing to the likelihood of attracting and retaining customers.

Insurance inputs can be classified into four groups: labor (x_1), business services (x_2), debt capital (x_3) and equity capital (x_4). Our labor variable is taken as the total number of employees. The price per unit of labor (p_1) is calculated by dividing total deflated salary and other benefits to employees with total employees. The business services is taken as commission to agents which is material input, which is deflated by CPI. The input price index for business services (p_2) is calculated by dividing total deflated commission to agents with total active agents.

The debt capital of insurers consists of funds borrowed from policyholders. These funds are measured in real terms as the life insurance fund deflated using CPI. The cost of the policyholder supplied debt capital (p_3) is the rate of interest realized on the mean life insurance fund. Equity capital is an input for the risk-pooling function because it provides assurance that the company can pay claims even if there are larger than expected losses. The equity capital has been taken as sum of shareholders paid up capital; general reserve; reserve for bad and doubtful debts, loans; reserve for house property and investment reserve. This value of equity capital deflated by CPI is considered an input category. Following the study of Gutfinger and Meyers (2000), the cost of equity capital (p_4) is taken as 9% + rate of inflation. To summarize we use

four inputs: labor, materials, policyholder-supplied debt capital, and equity capital. The data set related to LIC operations in 17 annual periods, are summarized in Table 1.

Table 1: Data on Outputs and Inputs (1982-83 - 1998-99)

y_1	y_2	x_1	x_2	x_3	x_4	p_1	p_2	p_3	p_4	Cost ($\sum p_i x_i$)
55.554	0.069	14.666	124385	933.253	4.770	0.000024517	0.000121662	0.1196	0.123	25.29692
50.507	0.079	12.909	125619	800.551	4.467	0.000023113	0.000104098	0.1237	0.222	27.85955
48.729	0.072	12.418	126620	751.369	4.017	0.000023293	0.000110113	0.1239	0.162	31 79997
41.580	0.075	11.019	125736	667.707	4.472	0.000021442	0.000101879	0.1229	0.180	34.24371
40.761	0.075	10.642	121410	599.789	2.866	0.000020486	0.000088333	0.1221	0.193	37.34902
36.980	0.070	10.318	123785	547.583	3.098	0.000019674	0.000079317	0.1243	0.192	39.92847
33.114	0.072	09.388	114927	498.157	3.121	0.000018937	0.000084563	0.1156	0.153	46.45461
27.733	0.080	08.509	104918	448.209	3.187	0.000018319	0.000082187	0.1195	0.208	51.58553
25.302	0.079	07.854	096289	410.419	3.406	0.000018933	0.000086409	0.1144	0.228	56.04889
23.508	0.076	07.087	088243	386.050	3.800	0.000020345	0.000089911	0.1113	0.180	62.84692
21.450	0.063	05.868	073283	350.695	4.040	0.000019775	0.000101529	0.1095	0.151	67.78321
18.913	0.059	04.524	072619	316.195	4.218	0.000018861	0.000081843	0.1050	0.186	78.47784
17.317	0.053	03.729	070207	302.129	2.008	0.000018765	0.000083699	0.1030	0.176	84.51210
16.489	0.051	03.332	066476	286.560	2.141	0.000019312	0.000083894	0.0987	0.179	95.67624
15.731	0.060	02.889	062977	275.643	2.274	0.000019547	0.000085656	0.0946	0.145	107.6882
13.221	0.051	02.655	060440	254.555	2.318	0.000019969	0.000067178	0.0919	0.175	113.0968
12.248	0.050	02.893	058595	243.147	2.444	0.000023478	0.000057550	0.0881	0.206	127.3371

Sample Selection

Our primary data source is the annual statements of Life Insurance Corporation of India (LIC) for the period from 1982-83 to 1998-99. LIC is the only state owned insurance, which has been in operation in India since 1956. See Appendix for the history of Indian LIC. Liberalization of the Indian Financial Sector started in the year 1991. We have taken the data for 17 years covering before and after the liberalization so that the any effect of opening of the economy on the monopoly status of LIC could be studied.

5. Results and Discussion

5.1 Efficiency Measures

This study applies the DEA technique to the Indian LIC data set and DEA results concerning efficiency measures are summarized in Table 2.

Table 2: Efficiency Measures (%)

Year	OE	OSE	CSE	TE	TSE	PSE	AE	ASE
1982/83	100.0	93.50	93.50	100.0	94.50	94.50	100.0	99.00
1983/84	99.10	91.40	92.20	100.0	92.50	92.50	99.10	98.80
1984/85	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1985/86	99.30	93.40	94.10	100.0	99.10	99.10	99.30	94.20
1986/87	97.70	92.80	95.00	100.0	100.0	100.0	97.70	92.80
1987/88	98.80	96.60	97.80	100.0	98.40	98.40	98.80	98.20
1988/89	99.90	99.00	99.10	100.0	100.0	100.0	99.90	99.00
1989/90	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1990/91	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1991/92	100.0	98.40	98.40	100.0	99.60	99.60	100.0	98.80
1992/93	99.30	99.20	99.90	100.0	100.0	100.0	99.30	99.20
1993/94	99.30	98.50	99.20	100.0	99.70	99.70	99.30	98.70
1994/95	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1995/96	92.70	92.30	99.60	96.30	95.10	98.70	96.20	97.10
1996/97	100.0	97.90	97.90	100.0	100.0	100.0	100.0	97.90
1997/98	100.0	95.80	95.80	100.0	100.0	100.0	100.0	95.80
1998/99	100.0	93.00	93.00	100.0	100.0	100.0	100.0	93.00

The empirical findings from this table are as follows:

Finding 1 (OE, TE and AE)

The OE trend as a whole exhibits more than 98% except for the year 1995-96. In particular, the last three periods (1996-97 - 1998-99) and the middle period (1989-90 - 1991-92) of our study show 100% overall efficiency. However, the TE column shows 100% except for the year 1995-96. The OE result indicates that there little scope to enhance productivity (TE) by reducing cost inefficiency. Meanwhile, AE, measuring the appropriateness of input/output mixes to a given input price vector has more or less same trend with OE because TE is 100% in all most all the years. This AE result indicates that in the short-run, LIC management including leadership, management style and decisional capability has been very effective.

Finding 2 (OSE, TSE and ASE)

Coming to the long run performance of LIC, we see that the OSE, TSE, and ASE have irregular trends. But this result clearly indicates that, under the assumption of CRS, the degrees of OSE, TSE, and ASE are

different from those of OE, TE and AE. The former was larger than the latter. Here it is important to note that as indicated by the name of OSE, the degree of this efficiency concept is determined by two factors, i.e. overall efficiency due to cost reduction effort and scale efficiency due to scale expansion. The performance of LIC since 1994-95 has been deteriorating. We find in the data set that with a declining output trend, equity capital (x_4) has increased though other inputs are decreasing. This explains the deterioration in TSE and ASE trends. Financial liberalization in India started in 1991 and by the year 1995-96, the number of financial intermediaries had increased, and this explains the declining performance of LIC. This finding of deterioration in performance measured by OSE for the last few years (1995-96 - 1998-99) is basically due to the poor management, as reflected by declining AE scores in the respective years.

Finding 3 (CSE and PSE)

As defined previously, CSE and PSE are determined by CSE = OSE / OE and PSE = TSE / TE, respectively. If CSE becomes 100%, we can identify that LIC has CRS in its cost minimizing effort. Our result show that LIC has CRS in its cost minimizing effort for the years: 1984-85, 1989-90, 1990-91, and 1994-95. Similarly, if PSE becomes 100%, LIC can be considered to have CRS in its production activity. Here, LIC has CRS in its production activity for the years: 1984-85, 1986-87, 1988-89, 1989-90, 1990-91, 1992-93, 1994-95, 1996-97, 1997-98, and 1998-99. When the CSE and PSE scores are less than 100%, we can conclude that LIC has increasing or decreasing returns to scale. We can conclude here that LIC operates under CRS in terms of both production and cost activity for the years 1984-85, 1989-90, 1990-91, and 1994-95, and either IRS or DRS for the remaining years.

5.2 Returns to Scale

Finding 4 (RTS)

The empirical findings of Table 2 can be reexamined in Table 3. Table 3 presents resulting DEA multipliers, scale measures (σ_1 and σ_2), degree of scale economies (DSE), and estimated cost, all of which are measured by DEA model (5) with L = U = 1. This table has three important findings related to RTS. First, LIC has exhibited $\sigma_1 > 0$ and $\sigma_2 = 0$ for the period from 1982-83 to 1993-94 except for the year 1991-92 and therefore, DSE scores are all greater than unity, indicating IRS prevailing in the following time periods. Furthermore, DSE = 1 (due to $\sigma_1 = 0$ and $\sigma_2 = 0$), exhibiting CRS was observed in the year 1994-95. Second, the size of DSE has been gradually diminishing from DSE = 2.336 in 1982-83 to DSE = 1.026 in 1990-91. This diminishing time trend found in DSE indicates that the importance of scale expansion has been gradually reduced in the LIC operation. The LIC production in the initial stage of production (1982-83 - 1990-91), exhibiting more than 100% in the DSE measurement in Table 3, indicates the importance level of the LIC's scale expansion to reduce its production cost. Third, DSE score are less than unity (due to $\sigma_1 = 0$ and $\sigma_2 > 0$) for the period from 1995-96 to 1998-99, indicating DRS. The reason for the decreasing returns to scale over the last four years can be explained through data set given in Table 1. The data show that over the years there is a clear diminishing trend in all the inputs and outputs up to the year 1994-95 and

thereafter all the outputs and inputs decreases except the input equity capital. The rise in equity capital is due to increase in the reserves for bad and doubtful debts and loans. With the given market prices on inputs, the unit cost has proportionately gone up due to increase in equity capital, which resulted in DRS to operate in the Indian LIC

Table 3: DEA Multipliers, Degree of Scale Economies, and Estimated Cost

Year	v_1	v_2	v_3	v_4	w_1	w_2	σ_1 (σ_2)	DSE	Estimated Cost
1982/83	0.000023	0.000058	0.0381	0.206	0.884	0	14.466 (0)	2.336	25.297
1983/84	0.000020	0.000067	0.0919	0.175	0.933	0	15.277 (0)	2.238	27.617
1984/85	0.000020	0.000086	0.0946	0.145	1.428	0	9.328 (0)	1.415	31.800
1985/86	0.000019	0.000084	0.0987	0.179	1.478	0	9.642 (0)	1.396	34.017
1986/87	0.000019	0.000084	0.1030	0.176	1.533	0	9.940 (0)	1.374	36.495
1987/88	0.000019	0.000082	0.1050	0.186	1.555	0	10.054 (0)	1.342	39.469
1988/89	0.000020	0.000102	0.1095	0.151	1.659	0	10.828 (0)	1.304	46.406
1989/90	0.000020	0.000090	0.1130	0.180	1.552	172.822	1.968 (0)	1.040	51.586
1990/91	0.000019	0.000086	0.1144	0.228	1.586	185.193	1.397 (0)	1.026	56.049
1991/92	0.000018	0.000082	0.1195	0.208	1.799	806.569	0 (51.566)	0.549	62.847
1992/93	0.000019	0.000085	0.1156	0.153	1.596	169.948	2.230 (0)	1.034	67.325
1993/94	0.000020	0.000079	0.1243	0.192	1.799	0	11.387 (0)	1.171	77.930
1994/95	0.000020	0.000088	0.1221	0.193	2.073	0	0 (0)	1.000	84.512
1995/96	0.000021	0.000102	0.1229	0.180	2.514	221.901	0 (32.523)	0.732	88.658
1996/97	0.000023	0.000110	0.1239	0.162	2.452	0	0 (11.816)	0.901	107.688
1997/98	0.000023	0.000104	0.1237	0.222	3.300	0	0 (55.978)	0.669	113.097
1998/99	0.000025	0.000122	0.1196	0.123	3.161	0	0 (48.271)	0.725	127.337

Given the monopoly nature of LIC, we find that it enjoys scale economies till 1993-94. LIC operates under CRS in the year 1994-95. The liberalization in 1990-91 resulted in competition in financial intermediation, which led to LIC to operate under decreasing returns to scale since 1995-96.

6. Summary and Conclusion

This study has used DEA approach to estimate eight different efficiency concepts: Overall Efficiency (OE), Overall and Scale Efficiency (OSE), Cost-Scale Efficiency (CSE), Technical Efficiency (TE), Technical and Scale Efficiency (TSE), Production-Scale Efficiency (PSE), Allocative Efficiency (AE), Allocative and Scale Efficiency (ASE), in the perspective of production and cost analyses. Furthermore, we have used a new approach of DEA to measure the degree of scale economies (DSE), developed by Sueyoshi (1997),

which provides information regarding returns to scale possibilities with respect to production and cost activity. We have examined the above efficiency measures by taking data from Life Insurance Corporation of India for the period 1982-83 through 1998-99. The research results of this study are summarized by the following empirical findings. The short run efficiency estimates indicate that LIC management has performed effectively. The long-run performance of LIC has been lower as compared to its short-run performance. In terms of PSE and CSE formulation, LIC is found to operate under CRS in terms of both production and cost activity for four years. Finally, the DSE result shows that LIC was operating under IRS from 1982-83 to 1993-94, CRS in the year 1994-95 and DRS for the periods 1995-96 to 1998-99. Given the above results, we conclude that LIC has lost its monopoly status in exploiting scale economies after financial liberalization in India.

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Appendix

Life Insurance in India

Life insurance in its existing form came in India from the United Kingdom (UK) with the establishment of a British firm, Oriental Life Insurance Company in Calcutta in 1818. Bombay Life Assurance Company in 1823, the Madras Equitable Life Insurance Society in 1829 and Oriental Government Security Life Assurance Company in 1874 followed this. Prior to 1871 Indian Lives were treated as sub-standard and charged an extra premium of 15% to 20% (Malhotra, 1994). Bombay Mutual Life Assurance Society, an Indian insurer that came into existence in 1871, was the first to cover Indian lives at normal rates.

By 1956, 154 Indian insurers, 16 non-Indian insurers and 75 provident societies were carrying on life insurance business in India. Life insurance business was confined mainly to cities and better off segments of the society.

On 19th January 1956, the management of life insurance business of 245 Indian and foreign insurers and provident societies, then operating in India, was taken over by the central government then nationalized on 1st September 1956. LIC was formed in September 1956 by an Act of Parliament, viz. LIC Act, 1956, with capital contribution of Rs.5 crores from the Government of India.

The Government of India appointed a Committee on Reforms in the Insurance sector under the chairmanship of the former governor of the Reserve Bank of India, Mr. R. N. Malhotra. The committee submitted its report to the Government of India, Ministry of Finance in January' 1994. According to the report, economic reforms, particularly those relating to the financial sector, raise several important issues regarding the insurance industry including, importantly, the following:

> A majority of areas previously reserved for the public sector have been thrown open to the private sector to strengthen the forces of competition. Competition is growing in the banking sector, which already includes numerous public sector banks as well as private sector banks, both, Indian and foreign. A similar trend is also evident among non-banking financial institutions, including leasing companies, mutual funds, merchant banks, and other intermediaries dealing with security business. In contrast, life and general insurance companies remain state monopolies. LIC is a monolith. The question arises as to why the consumer of insurance services should not be provided a wider choice so that he can get the benefits of competition in terms of range of insurance products, lower price of insurance cover and better customer service.