CAPACITY UTILIZATION IN INDIAN AIRLINES

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Abstract

The financial performance of the state-owned Indian Airlines has deteriorated since 1989-90. The main reasons cited for the poor financial performance of Indian Airlines include: rising fuel prices, excess staff, serving uneconomic routes and increasing expenses on insurance. However, low capacity utilization has rarely been cited as one of the main reasons for the poor performance. The present study thus makes an attempt to measure the extent of capacity utilization in Indian Airlines and its impact on the unit cost of production. Using data from 1964-65 to 1999-00 and applying a translog variable cost function, the capacity utilization has been estimated with respect to two alternative measures of potential output: (i) where short-run average cost is minimum, and (ii) where short-run and long-run average cost curves are tangent. The results reveal that the capacity utilization in Indian Airlines has been poor in general and also declining over the last decade. Therefore, the study suggests a need to improve the capacity utilization, which in turn would improve the financial performance of Indian Airlines by reducing its cost per unit of output.

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I. INTRODUCTION

Capacity utilization has an important bearing on the financial performance of any organization. This can be stated as being especially true for domestic and state-owned Indian Airlines, which has incurred losses for as many as 10 financial years in between 1989-90 and 2001-02. The cumulative net losses amounted to Rs 14.55 billion against a cumulative profit of just Rs 1.13 billion for this period. This happened despite several bouts of increase in fares at various points in time (Abreu 1998). The bad financial performance of Indian Airlines is not sufficiently attributed to poor capacity utilization, a fact which has been overlooked as it is protected by the government; rather other factors such as increasing fuel cost, excess employees and rising insurance expenses are faulted heavily. Against this background, it is not surprising to know that Indian Airlines is planning to add as many as 43 new airbus aircraft to its fleet, costing over $ 2 billion (Bereaus 2002).

Even without undertaking a detailed economic analysis, the problem of under utilization of capacity by Indian Airlines is obvious. There are at least five reasons to believe so. First, excess fleet is not being disposed off, as it may not fetch the expected price in the second hand aircraft market. This is because the aircraft to be disposed off are very old and continuing with them in service seems a better option. Second, the load factor on many short routes falls even below 50% (Planning Commission 1987). Third, between 1987-88 and 1999-00, the level of output measured in available ton kilometer declined by about 3% whereas the capital stock increased by 110%. The decline in output was registered mainly due to the entry of private scheduled airlines under the 'open sky policy' since 1991. Fourth, in 1997-98, the average daily flying time per aircraft in Indian Airlines was just 8 hours whereas the same in one of its main competitors, Jet Airways, was 10.5 hours (Karmali 1998). As a result, the utilization in terms of flying time per aircraft per annum has fallen far below the norm of 2700 hours, as recommended by the Kelkar Committee Report (1996).[1] Fifth, Jet Airways with a fleet strength of 38 aircraft has

[1] The exception was in the year 1997-98.

captured almost 49% market share, while Indian Airlines with a fleet of 57 aircraft has been able to manage a share of less than 40% (Paul 2002; Das 2002).

If the capacity is utilized optimally, it will not only help in reducing the cost per unit of the services provided but will also provide the advantage of widening the market by making Indian Airlines more competitive. Capacity utilization can be defined as the ratio of actual output to some measure of potential output, which can be seen from two angles. Of these, one is technically maximum output while the other is the optimum from economics point of view. Cassel (1937) favors the employment of economic criteria of potential output. Within the economic criterion of potential output, there are again two alternative versions suggested by: (a) Cassel (1937) and Hickman (1964): the output at which the short-run average total cost curve is at the minimum; and (b) Klein (1960) and Friedman (1963): the output at which the short-run and long-run average total cost curves are tangent. But in the case of Indian Airlines no systematic study exists on capacity utilization; particularly one that measures the potential output for a given capacity from economics point of view. Thus, rendering the extent of capacity utilization merely a matter for conjecture.

This being so, an attempt has been made here to overcome this lacuna. Thus, the main objective of this study is to: (i) estimate both the economic measures of capacity utilization for Indian Airlines using a translog variable cost function, and (ii) show by what per cent the cost could have been reduced if the capacity was utilized optimally in Indian Airlines.

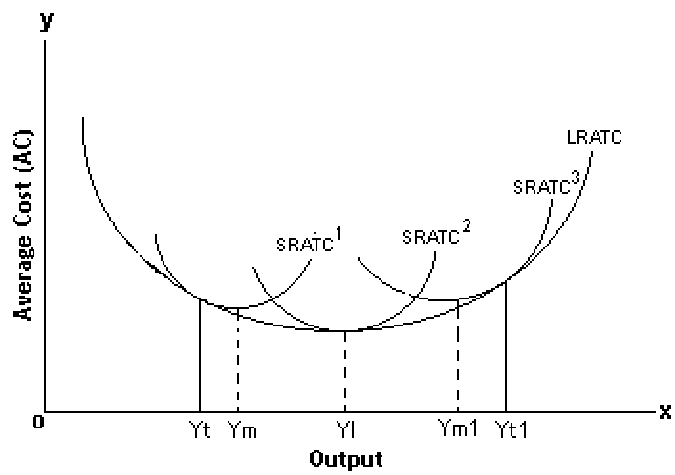
The rest of the paper is organized as follows: in Section II the methodology is discussed. Section III provides sources of data and explains construction of variables along with their trends. In Section IV the empirical findings are discussed. Summary and conclusion of the analysis are presented in Section V.

II. METHODOLOGY

A. *Measurement of Potential Outputs*[2]

It would be useful to begin with a graphical explanation of the two economic measures of potential output. In Fig. 1, the traditional U-shaped short-run and long-run average cost curves are shown. The potential output corresponding to the short-run is indicated by Y_m and Y_{m1} whereas the same corresponding to the long-run is indicated by Y_t and Y_{t1}. The two potential outputs would converge at the Y_1 level when constant returns to scale are assumed. In case of increasing returns to scale, $Y_t < Y_m$ whereas in case of decreasing returns to scale, $Y_{t1} > Y_{m1}$.

Figure 1: Short-Run and Long-Run Average Cost Curves



The two economic measures of potential output can be arrived at by utilizing the following short-run total cost (*SRTC*) function:

$$SRTC = TVC + TFC$$

or, $$SRTC = TVC + (r \times K), \qquad \text{-------------------(1)}$$

where, *TVC* = total variable cost, *TFC* = total fixed cost, *K* = stock of capital, and *r* = price of capital (rental).

[2] This section borrows heavily from Nelson (1989).

By dividing equation (1) by output (Y), the following short-run average total cost ($SRATC$) function is derived:

$$SRATC = \frac{TVC}{Y} + \frac{(r \times K)}{Y}. \qquad \text{---------------------(2)}$$

One of the measures of potential output corresponds to the short-run, when the size of capital is fixed and the potential output level is determined at the point where SRATC is the minimum. If Y_m is defined as output which minimizes the $SRATC$, then $\partial SRATC / \partial Y_m = 0$. In terms of equation (2), this can be written as:

$$\frac{\partial SRATC}{\partial Y_m} = \left(\frac{1}{Y_m}\right)\left(\frac{\partial TVC}{\partial Y_m}\right) - \left(\frac{TVC}{Y_m^2}\right) - \left(\frac{r \times K}{Y_m^2}\right) = 0. \qquad \text{-------------(3)}$$

In order to solve for Y_m, the expression $\partial TVC / \partial Y_m$ in equation (3) can be substituted with $(\partial \ln TVC / \partial \ln Y_m)(TVC / Y_m)$, as $(\partial \ln TVC / \partial \ln Y_m) = (\partial TVC / \partial Y_m)(Y_m / TVC)$.

Assuming that the variable cost function is translog, and is defined by equation (8),

$$\frac{\partial \ln TVC}{\partial \ln Y_m} = b_y + b_{yy} \ln Y_m + \sum_i b_{iy} \ln P_i + b_{ky} \ln K + b_{yt}(t). \qquad \text{-------------(4)}$$

As Y_m and $\ln Y_m$ both appear in equation (3), an iterative procedure is employed to solve for Y_m.

The alternative measure of potential output suggested by Klein (1960) and Friedman (1963) corresponds to the long run, when short-run and long-run average cost curves are tangent. In the long run, when all the factors are variable, a firm chooses to employ that size of plant, which minimizes the short-run total cost for a given level of output. In terms of equation (1) it implies:

$$\frac{\partial SRTC}{\partial K^*} = \frac{\partial TVC}{\partial K^*} + r = 0, \qquad \text{--------------------------(5)}$$

where, K^* = equilibrium size of capital.

Equation (5) shows that in long run, the equilibrium size of capital is the one where the reduction in variable cost resulting from an increase in last unit of capital is equal to the price of capital.

Making use of equation (5), the present study attempts to solve for equilibrium levels of output (Y_t) for the observed sizes of capital. This is done by substituting $(\partial TVC/\partial K)$ by $(\partial \ln TVC/\partial \ln K)(TVC/K)$, as $(\partial \ln TVC/\partial \ln K)$ = $(\partial TVC/\partial K)$ (K/TVC), where,

$$\frac{\partial \ln TVC}{\partial \ln K} = b_k + b_{kk} \ln K + \sum_i b_{ki} \ln P_i + b_{ky} \ln Y_t + b_{kt}(t). \qquad \text{-----------------(6)}$$

Again an iterative procedure is employed to solve for Y_t, because in equation (5), Y_t appears in two forms, Y_t and $\ln Y_t$.

B. *Specification of Cost Function*

For determination of the alternative potential outputs Y_m and Y_t corresponding to equations (3) and (5), respectively, a variable cost function is needed. Following Lau (1976), when a firm attempts to minimize the variable costs for producing a given level of output, with given capital stock, there exists a total variable cost function as:

$$TVC = f(P_i, Y, K, t), \qquad \text{-------------------- (7)}$$

where, TVC is the minimum variable cost, P_i is a vector of input prices, Y is output, K shows stock of capital and t represents the technology.

For the purpose of the present study, the following form of translog variable cost function is estimated:

$$\ln TVC = b_0 + b_Y \ln Y + \sum_i b_i \ln P_i + b_k \ln K + b_t(t) + \frac{1}{2} b_{yy} (\ln Y)^2 + \frac{1}{2} \sum_i \sum_j b_{ij} \ln P_i \ln P_j$$

$$+ \sum_i b_{ki} \ln K \ln P_i + \frac{1}{2} b_{tt} (t)^2 + \sum_i b_{iy} \ln P_i \ln Y + \sum_i b_{it} \ln P_i (t) + b_{yt} \ln Y(t), \quad \text{----------(8)}$$

where, $b_{ij} = b_{ji,}$ TVC = total variable cost, b_0 = constant term, Y = output (available ton kilometer), K = capital stock, P_i = vector of input prices, t = trend variable.

For a well-behaved production function, the following restrictions need to be imposed on the variable cost function (8) so that it is homogeneous of degree one in input prices:

$$\sum_i b_i = 1, \quad \sum_i b_{iy} = 0, \quad \sum_i b_{ij} = \sum_j b_{ji} = \sum_i \sum_j b_{ij} = 0, \quad \sum_i b_{it} = 0, \quad \text{-----------(9)}$$

In order to improve the efficiency of the estimates, a translog variable cost function is estimated along with share equations. The share equations (S_i) for each factor can be arrived at by differentiating the total variable cost function with respect to input prices. The resulting share equations, known as Shephard's lemma (Shephard 1953), take the following form:

$$\frac{\partial \ln TVC}{\partial \ln P_i} = S_i = b_i + b_{ii} \ln P_i + \sum_i b_{ij} \ln P_j + b_{iy} \ln Y + b_{ki} \ln K + b_{it}(t), \quad \text{--------(10)}$$

$$(i = l, e).$$

For this study, the specified cost function and the share equations have been estimated jointly with the help of the econometrics software package, 'Shazam', applying the non-linear maximum likelihood method. To overcome the problem of singularity, following the common procedure, one of the share equations (labour equation in this study) is arbitrarily dropped from the system estimation. Here it should be noted that the resulting maximum likelihood estimates are invariant to the equation deleted (Barten 1969).

The main advantage of the translog cost function is that it allows a simplification of the model by imposing several alternative restrictions on a well-behaved non-homothetic cost function. A cost function is homothetic, if $b_{iy} = 0 \ \forall \ i = 1 \ldots n$. Further, it is homogenous of constant degree in output, if $b_{iy} = 0$ ″ $i = 1 \ldots n$, and $b_{yy} = 0$.

The validities of various restrictions, mentioned above, are checked with the help of a likelihood ratio test (Christensen and Greene 1976). The likelihood ratio statistics (λ) is calculated as:

$$l = 2(\ln U - \ln R), \qquad \text{-----------------------(11)}$$

where, $\ln U$ and $\ln R$ are the values of the likelihood ratio statistics of unrestricted and restricted models, respectively. Here l follows asymptotically a chi-square distribution with a degree of freedom equal to the number of independent restrictions imposed.

A well-behaved cost function, in addition to being homogeneous of degree one in input prices, should also be: (i) non-decreasing in input prices ($\partial TVC / \partial P_i \geq 0$), (ii) non-increasing in K ($\partial TVC / \partial K \leq 0$), (iii) non-decreasing in Y ($\partial TVC / \partial Y \geq 0$), (iv) convex in K ($b_{kk} \geq 0$), and (v) concave in P_i (for details, see Barik 2001). The concavity condition would be satisfied if the 'n ´ n' matrix of substitution elasticities is negative semi-definite at each observation (see Berndt 1992).

III. DATA AND VARIABLES

A. *Sources of Data*

Estimation of the variable cost function requires data on the prices of factors and the quantities of inputs and output, which were collected from various annual reports of the Indian Airlines. Besides this, the required data were also collected from various other sources like Chandhok (1990), various publications of Center for Monitoring Indian Economy (CMIE), and the Internet site of www.circonindia.com. The annual data from 1964-5 to 1999-00 are used for the estimation purpose.

B. *Construction of Variables*

For the purpose of estimating the variable cost function, the total expenses are divided into three broad categories: labour (l), capital (K) and energy/materials (e). The inputs, energy and materials are clubbed together in line with some of the studies (for example, Jha, Murty and Paul 1991) to facilitate a larger degree of freedom in estimation. The labour and energy/materials are taken as the variable factor, whereas the capital is assumed to be a quasi-fixed factor; the quantity of which can be changed only in the long run. The price index of labour is derived by dividing the total labour expenses by the total number of employees in a year. The price index of air turbine fuel is obtained from Chandhok (1990) and various publications of CMIE. The general wholesale price index is used as a proxy for the price of material because it includes varieties of inputs, which are not included in other categories (Gillen et al. 1990). A weighted price index of energy and materials (P_e) is then obtained using the individual price indices of energy and materials. Here it should be noted that the quantity indices of labour and materials do not fully take into account the heterogeneity of these inputs. The lack of requisite data has not permitted the avoidance of this limitation.

The total capital consists of three broad categories: (a) aircraft, (b) machines, and (c) other miscellaneous. The first category account for the largest share of about 84% in the total gross assets, whereas the remaining two categories have equal shares. Due to lack of data on the prices of aircraft over the years, available seats are taken to represent the quantity of capital associated with aircraft. It should be noted here that there has been a qualitative improvement in the capital with passage of time, as better quality of aircraft have been inducted from time to time. This implies that in real terms one seat of the current year is worth more than the same of the previous year. Hence, a proper adjustment in the available seats is required to be made to overcome the problem of heterogeneity of the same capital. The adjustment in the series of capital is made with the help of an adjusted price index. Two price indices are considered for this purpose: (i) a price index obtained by dividing the gross block of capital by the number of available seats in a year, and (ii) a price index of transport equipments and parts. It may be noted that that the first index, besides having an inflation effect, would also have the effect of an improvement in the quality of capital, and hence, would overstate the increase in prices. The second index, on the other hand, represents the price index of transport items in general and hence, would understate the actual rise in the price of airline assets for at least two reasons. First, there is not as much competition in the aircraft manufacturing as may be the case with other transport items. Second, as the aircraft are imported from developed countries, the decline in value of rupees over time makes the increase in aircraft prices higher than those of indigenous transport items. The two price indices so obtained have been used to arrive at the average price index for deflating the gross assets related to aircraft. For the second category of assets relating to machines, the price index of machine and machine tools is taken as a proxy. In view of the varieties of items included in the last group of assets, a general wholesale price index is considered as a proxy for this group.

Assuming that the flow of service is proportional to stock, the following perpetual inventory method is used to create the real capital stock series for each of the three capital inputs (Christensen and Jorgenson 1969):

$$K_{it} = I_{it} + (1 - d_i) K_{i,t-1}, \qquad \text{--------------------(12)}$$

where, K_{it} = the real capital stock of category i at year t, I_{it} = the real value of net investment on category i at time t, and $d_i = 1/n_i$, where n_i = economic life of asset i, showing a constant rate of depreciation of asset i over its life span.

The average economic life of an aircraft is assumed to be 20 years. This is based upon the depreciation practice followed in Indian Airlines, where the aircraft and engines are depreciated on a straight line basis and the 10% residual value is brought down to 1% every two years. The life of capital associated with machines, in line with Basant and Fikkert (1996), has been taken as 16 years. The assets in miscellaneous categories have items of relatively shorter life spans and hence, an average of 12 years is selected as the economic life of such assets.

The price of the services of each of the capital inputs is computed to reflect a one period 'user cost of capital'. As the stock of capital with Indian Airlines is by and large of non-rental category, and since a well-developed rental market does not exist for such capital, the price of capital service is derived indirectly. Hall and Jorgenson (1967) argue that the price of capital services should include four components: (i) the opportunity cost of capital, (ii) depreciation associated with the use of capital, (iii) expected capital gains or losses, and (iv) expected changes in direct taxes at the time of purchasing the capital goods. In this study, it is possible to use only the first two components, due to non-availability of data. Thus, the price of capital services for each of the three categories is calculated as:

$$P_{ki} = P_{ni}(R + d_i), \qquad \text{---------------------(13)}$$

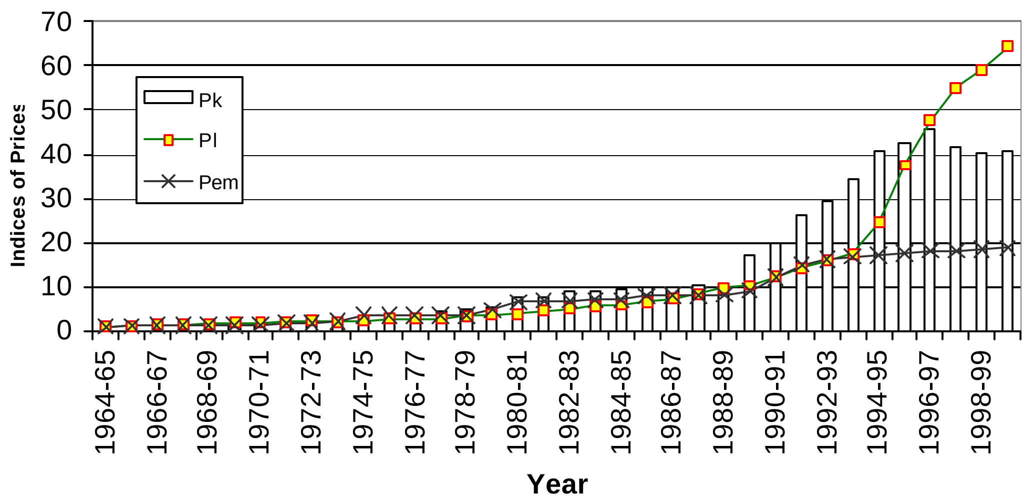
where, P_{ni} = price of investment goods i, R = current interest rate (the long-term lending rate of the Industrial Development Bank of India), d_i = depreciation rate of assets i, ($d_i = 1/n_i$, where, n_i = economic life of the asset i).

With regard to the measure of output, a producer related measure 'available ton kilometer' (*ATK*) is chosen for the estimation purpose. A ton kilometer of output is equivalent to the carriage of one ton over a kilometer. Thus, the *ATK* represents the capacity output. The reason for using a producer-related measure of output is that the major cost items like labour, energy and materials are likely to be more correlated with this measure than the 'user related' measure of output. This enhances the possibility of good statistical results (see Sarkar 1997).

C. *Trends in Variables*

In order to provide a picture of the relative changes of various indicators of Indian Airlines over the study period, various figures have been drawn. Fig. 2 explains the changes in the relative prices of the three inputs. The prices of inputs have been increasing somewhat gradually upto the year1988-89. However, in the year 1989-90 came a sudden jump in the price of capital, caused by the induction of costlier A-320 aircraft, a process that continued till 1996-97. The labour price, on the other hand, started increasing sharply after 1993-94 and registered a maximum increase amongst all inputs.

Figure 2: Price Indices of Inputs (1964-65 = 1)



The trends in quantities of output (*ATK*) and inputs of the Indian Airlines are shown with the help of Fig. 3. The output has been gradually increasing upto the year 1987-88. The outputs of the subsequent years have fallen short of this level. On the other hand, the stock of capital in between 1987-88 and 1999-2000 has gone up over double. This makes us suspect a relatively higher degree of under-utilization of capital in between 1988-89 and 1999-2000. The quantity index of labour does not show much of an increase and towards the end there is a slight declining trend, whereas the index of energy/materials is seen as rising steadily, with a few exceptions.

Figure 3: Quantity Indices of Output and Inputs (1964-65=1)

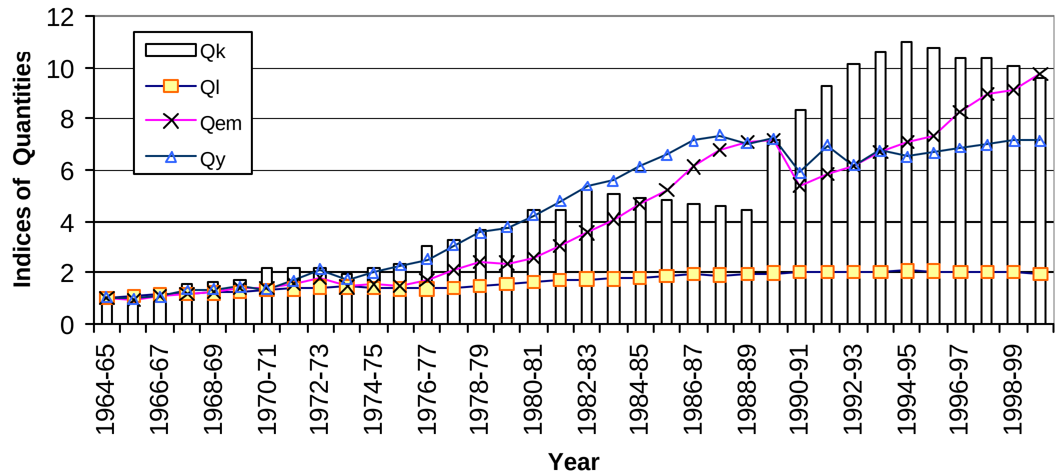
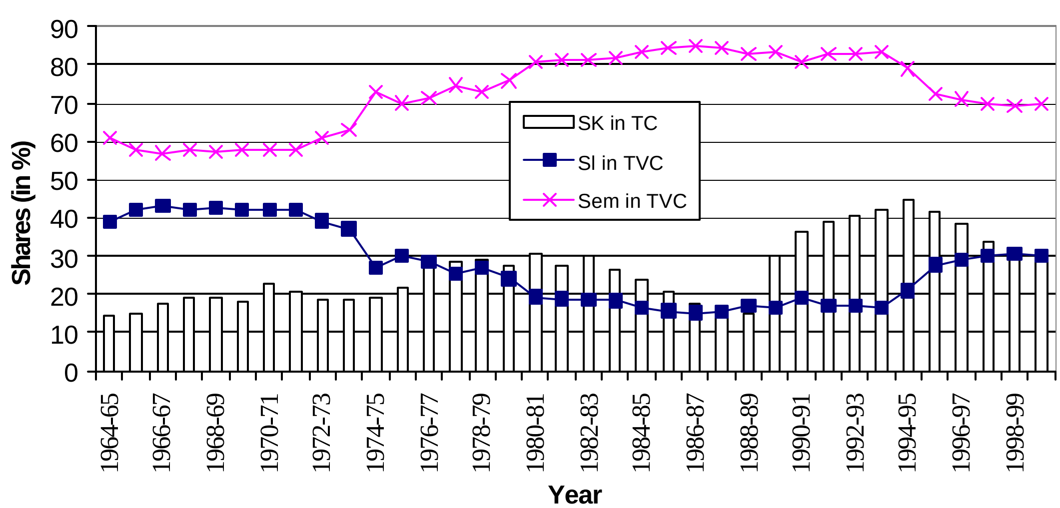


Fig. 4 shows the trends in shares of labour and energy in total variable cost (*TVC*) and also the share of capital cost in the total cost. It can be seen that the share of labour has declined over the years. There is also a trend of increasing capital cost in the total cost.

Figure 4: Shares of Inputs (S_i) in Expenses



IV. EMPIRICAL FINDINGS

A. *Estimate of the System of Equations*

The estimates of the parameters in the system of equations are reported in Table 1. Of the 21 coefficients estimated, 12 are statistically significant at the 5% level. The first order coefficients have the expected sign, and except capital and time all are statistically significant at the 5% level. The negative first order coefficient of capital shows its positive shadow value. In the second order coefficients, the interactions of labour and energy with time as well as output are statistically significant.

Table 1: Estimates of Translog Variable Cost Function

Variables	Coefficient	T-Ratio
b_0 (Constant)	12.9290	8.3947*
b_k (Capital)	-0.15809	-1.0864
b_e (Energy/materials)	0.25659	3.6924*
b_l (Labour)	0.74341	3.6924*
b_y (Output)	0.26532	2.4086*
b_t (Time)	-0.02120	-0.2837
b_{kk}	-0.04770	-0.1279
b_{ke}	-0.00641	-0.3322
b_{kt}	0.02216	0.8911
b_{kl}	0.00641	0.3322
b_{ee}	0.15822	10.8060*
b_{ky}	-0.17531	-0.8963
b_{el}	-0.15822	-10.8060*
b_{ey}	0.12311	5.6625*
b_{ly}	-0.12311	-5.6625*
b_{ll}	0.15822	10.8060*
b_{yy}	0.82115	2.1932*
b_{et}	0.01038	4.5432*
b_{lt}	-0.01038	-4.5432*
b_{yt}	-0.02751	-1.0009
b_{tt}	0.00186	0.7152
RHO	0.93609	48.8120*

Notes:(1) Coefficients involving ‘labour’ are calculated using the identity in equation (9).
(2) T-ratios of the coefficients involving ‘labour’ have been calculated indirectly, with the help of variance-covariance matrix.
(3) * indicates that the coefficient is statistically significant at the 5% level.

The estimated cost function and share equations give a good fit as the values of R^2 between actual and estimated levels for the variable cost function and the energy share equation are 0.99 and 0.98, respectively. In estimation of the system equations, the problem of positive autocorrelation was detected in both the estimated equations. Assuming the first order autocorrelation between error terms in the same equation, this problem is removed. The *D-W* statistics for the variable cost function is 2.14 and the same for the energy share equation is 2.36. Further, a non-homothetic structure of cost function is chosen for the present study on the basis of the likelihood ratio statistics. The likelihood ratio statistics for the homothetic cost function is 43.16 with 3 degrees of freedom and for the homogenous cost function it is 65.65 with 4 degrees of freedom, indicating thereby that neither of these structure should be imposed on cost function, as these chi-square values exceed the respective table values.

The estimated variable cost function is non-decreasing in input prices and output at each observation. The condition of 'non-increasing in *K*' is satisfied only at 72% of the observations, but at the sample means this condition is satisfied.[3] There is violation in the condition of the convexity of cost function in K, as the value of b_{kk} turned out to be negative. It should be noted, however, that the coefficient b_{kk} is statistically not significant at the 5% level and hence its sign may not be conclusive. The own elasticity of substitution for energy and labour both turned out to be negative at each observation, as required for meeting the concavity condition.

Since the above results are derived using the time series data, it is necessary to ensure that the variables used in the model are cointegrated. Unfortunately, the test of cointegration is quite complex in a case of multivariate regression analysis encompassing a system of equations as in this study. To overcome this limitation to some extent, the attempt is made to test the stationarity of each of the variables with the help of 'augmented Dickey-Fuller' unit root test.[4] The results show that the time series of all the variables are non-stationary. But these time series are found to be

[3] A number of empirical studies (for example, Bharadwaj 1994; Park and Kwon 1995; Barik 2001) have reported violation in this condition at a few observations.

[4] Please see the appendix for the procedure and results of the test of stationarity.

integrated of the order one, i.e., I (1). Since all the times series are integrated of the same order, it is assumed that they might be cointegrated as well.

B. *Capacity Utilization*

The capacity utilization has been measured as a ratio of actual output to two alternative potential outputs. The capacity utilization corresponding to the minimum *SRATC* and the tangency between *SRATC* and *LRATC* curves are expressed as CU_m and CU_t, respectively. The empirical results are depicted in Table 2. The following important observations can be made from the results:

a. Both the measures of capacity utilization show the values as less than unity for all but two (first two of CU_t) observations. At the sample average, CU_m is 32% while CU_t is 37%. This shows that the actual output of Indian Airlines has fallen far short of both the measures of potential output. Further, there is an obvious declining trend in CU_t over the years, indicating a widening difference between the long-run potential output and the actual output. It only highlights that the effective correction of the problem of excess capacity has never been on the agenda of the Indian Airlines.

b. The CU_m and CU_t both have registered a sharper decline from the year 1989-90, having reached a level as low as 10% and 6%, respectively in the last year of the sample. This was the result of increasing capacity on the one hand and decline of its market share on the other. A number of factors like the grounding of the entire fleet of A-320 aircraft for a year following the Bangalore air crash, entry of private airlines, exodus of pilots led to the decline in market share.

c. The year 1975-76 represents a dividing line, prior to which $CU_t > CU_m$ and after which $CU_m > CU_t$ for all the observations. This points to the existence of the theoretical *U*-shaped average cost curves in the Indian Airlines. The actual output, however, has always fallen in the region of increasing returns to scale, confirmed by estimating the returns to scale (*RTS*) as follows (Caves et al. 1981):

$$RTS = \frac{1-(\partial \ln VC / \partial \ln K)}{(\partial \ln VC / \partial \ln Y)}, \qquad \text{-----------------(14)}$$

where, $(\partial \ln TVC / \partial \ln Y)$ and $(\partial \ln TVC / \partial \ln K)$ are calculated using equations (4) and (6), respectively.

At the sample average, the value of *RTS* turned output to be 2.5. It may be pertinent to note here that the total cost function approach also provided similar value for *RTS* measuring 2.2 (see Hashim 2002).

d. As both CU_m and CU_t are less than unity, it indicates that the Indian Airlines could have reduced its short-run generation costs by moving to the tangency point or minimum point on the given short-run cost curve. In order to see as to what extent the actual average cost could have been reduced with a better utilization of capacity, the ratios of the short-run actual average cost to *SRATC* at minimum point and *SRATC* at tangency point are calculated using equation (8) and are shown in Table 2. It can be seen from the table that at the sample average, the short-run generation costs could have been reduced by 2.3 times had the Indian Airlines been operating at the minimum point on its *SRATC* curves, and by 1.9 times had it been operating at the point of tangency between the *SRATC* and *LRATC* curves.

e. As the capacity utilization became worse from the year 1989-90, the increasingly larger opportunity of reducing short-run generation costs was lost from this year onwards. In between 1989-90 and 1999-2000, the Indian Airlines could have lowered its short-run average generation costs by 4.23 times if it had produced outputs at the minimum point of the *SRATC* curves and by 3.4 times if it had produced outputs at the tangency points between the *SRATC* and *LRATC* curves.

Table 2: Capacity Utilization and Ratio of Actual to Potential SRATC

Year	Ratio of Actual Output to Output at		Ratio of Actual *SRATC* to *SRATC* at	
	Minimum SRATC (CU_m)	*Tangency Point** (CU_t)	*Minimum Point*	*Tangency Point**
1964-65	0.38	1.36	1.48	0.76
1965-66	0.35	1.11	1.54	0.91
1966-67	0.33	0.83	1.65	1.17
1967-68	0.37	0.81	1.49	1.17
1968-69	0.35	0.70	1.53	1.27
1969-70	0.35	0.63	1.53	1.34
1970-71	0.29	0.43	1.81	1.69
1971-72	0.34	0.48	1.56	1.49
1972-73	0.42	0.54	1.35	1.32
1973-74	0.37	0.46	1.49	1.45
1974-75	0.40	0.45	1.38	1.38
1975-76	0.41	0.41	1.38	1.38
1976-77	0.37	0.34	1.48	1.48
1977-78	0.41	0.36	1.38	1.37
1978-79	0.41	0.34	1.39	1.36
1979-80	0.43	0.34	1.35	1.32
1980-81	0.43	0.32	1.36	1.30
1981-82	0.45	0.33	1.32	1.26
1982-83	0.42	0.30	1.40	1.31
1983-84	0.42	0.29	1.41	1.30
1984-85	0.45	0.31	1.33	1.22
1985-86	0.47	0.31	1.30	1.17
1986-87	0.49	0.32	1.26	1.13
1987-88	0.47	0.30	1.30	1.15
1988-89	0.42	0.26	1.40	1.21
1989-90	0.28	0.18	1.97	1.68
1990-91	0.21	0.13	2.62	2.22
1991-92	0.21	0.13	2.62	2.19
1992-93	0.17	0.10	3.30	2.72
1993-94	0.16	0.10	3.42	2.79
1994-95	0.13	0.08	4.45	3.59
1995-96	0.11	0.07	5.25	4.17
1996-97	0.10	0.06	5.67	4.44
1997-98	0.10	0.06	5.75	4.46
1998-99	0.10	0.06	5.64	4.30
1999-2000	0.10	0.06	5.82	4.35
Average	**0.32**	**0.37**	**2.29**	**1.91**

Notes:(1) * Tangency point refers to the point of tangency between *SRATC* and *LRATC*.
(2) *SRATC* = Short-Run Average Total Cost, and *LRATC* = Long-Run Average Total Cost.

V. SUMMARY AND CONCLUSION

In spite of a poor financial performance by the Indian Airlines since 1989-90, it proposes to expand its capacity in a large way. This projects the erroneous impression that it is suffering from a shortage of capital, mainly in terms of aircraft. In this paper, therefore, an attempt has been made to figure out the extent of capacity utilization in Indian Airlines over a period between 1964-65 and 1999-2000. Further, with the help of a translog variable cost function, two alternative measures of potential output are estimated. One, where $SRATC$ is the minimum for a given stock of capital, and two, where $SRATC$ and $LRATC$ curves are tangent. Accordingly, the ratios of actual output to the potential outputs relating to the former and later are indicated by CU_m and CU_t, respectively.

Both the measures of capacity utilization indicate the presence of excessively large idle capacity in the Indian Airlines for almost the entire study period. The CU_m and CU_t are found to be only 32% and 37%, respectively. Further, the problem of idle capacity has aggravated from the year 1989-90 onwards. It declined to a low level of 10% with respect to CU_m and 6% with respect to CU_t by the year 1999-00. Although the presence of the U-shaped of long-run average cost curve is noted, the Indian Airlines has produced outputs in the range of increasing returns to scale. This resulted in excess capacity. As both CU_m and CU_t are less than one, there existed a possibility of lowering the short-run generation costs, either by moving to the point of the minimum $SRATC$ curve or to the point of tangency between the $SRATC$ and $LRATC$ curves. The average cost would have been lower to the extent of 2.29 times in the former case and 1.91 times in the later case, at the sample average. For the period between 1989-90 and 1999-2000, these cost savings would have been even larger, measuring 4.23 times and 3.36 times, respectively. It was during this period that the financial performance of Indian Airlines deteriorated heavily, inspite of a number of fare hikes, indicating that the worsening of capacity utilization had contributed to the losses.

Hence, from the above it can be concluded that there lies an immense scope of improving the capacity utilization in Indian Airlines. But this is not to understate the importance of the renewal of fleet from time to time, as long as it is done in a phased and cautious manner. A smaller size of fleet with efficient management should surely help the Indian Airlines in overcoming its losses and confidently face the growing competition in the years to come.

APPENDIX 1.

Stationarity of Variables Used in Regressions

A series 'Y_t' is said to be stationary if its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods, i.e.,[5]

Mean:	$E\ (Y_t) = \mu$	---------------(1)
Variance:	$var\ (Y_t) = E\ (Y_t - \mu)^2 = ó^2$	---------------(2)
Covariance:	$cov\ (Y_t,\ Y_{t+k}) = E[(Y_t - \mu)(\ Y_{t+k} - \mu)] = ã_k$	---------------(3)

A series is said to be integrated of order 'd', denoted as 'I (d)' if it has to be differenced 'd' times to attain stationarity. Hence, a stationary time series is integrated of order zero and is indicated as 'I (0)'.

In order to check whether a series Y_t is stationary or not, the 'augmented Dickey-Fuller' (ADF) unit root test is applied to the following form of equation:

$$\Delta Y_t = a_1 + a_2 t + dY_{t-1} + q_i \sum_{i=1}^{m} \Delta Y_{t-i} + e_t \qquad \text{------------------------(4)}$$

Where ä = ñ –1, and $å_t$ = white noise. The null hypothesis is that ä = 0 or, ñ = 1, that is, a unit root exists in Y_t (i.e., Y_t is non-stationary). If the computed absolute value of Dickey Fuller 't' statistics for coefficient 'ä' exceeds the critical Dickey Fuller 't' statistics at a specified level of significance, then the null hypothesis is rejected and the series 'Y_t' is considered to be stationary or I (0). Otherwise, the time series is non-stationary.

The results of the augmented Dickey Fuller unit root test, corresponding to equation (4), are reported in tables 1 and 2. As per the results of table 1, the null hypothesis is accepted in all cases, which means that time series of all the variables are non-stationary. The results of table 2, on the other hand, show that the null hypothesis is rejected in every case, and hence the variables can said to be integrated of order one, i.e., I (1).

[5] Please see Gujarati (1995) for details.

Critical values for Dickey – Fuller 't' statistics are: –4.2505, -3.5468 and –3.2056 at 1%, 5% and 10%, respectively.

Table 1: Results of the augmented Dickey-Fuller test of Stationarity for 'I (0)'

Variable	**Lag (0)**	**Lag (1)**	**Lag (2)**	**Lag (3)**
TVC	2.054790	1.175294	-	-
Q_y	-1.264436	-0.599205	-1.365989	-1.937729
Q_k	-1.623467	-2.214222	-2.831471	-
P_l	2.582711	-0.809932	2.043380	2.012362
P_e	-1.758194	-2.651578	-1.980285	-

Table 2: Results of the augmented Dickey-Fuller test of Stationarity for 'I (1)'

Variable	**Lag (0)**	**Lag (1)**	**Lag (2)**	**Lag (3)**
TVC	4.265907	-	-	-
Q_y	-8.197122	-	-	-
Q_k	-3.801885	-	-	-
P_l	-2.313688	-3.368624*	-	-
P_e	-3.019751	-4.122436	-	-

Note: '' shows that the null hypothesis is rejected at the 10% level.*

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