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EFFICIENCY OF LOW-COST AIRLINES USING DEA: TOURISM OF INDIA PERSPECTIVE

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ABSTRACT

Nowadays market share of low-cost airlines is increasing rapidly due to tourism interest in India, but also is experiencing unfortunate monetary condition because of a few reasons. To beat the position, airlines need procedures to impact turnaround of the carriers for the various purposes which include tourism since the operating sectors of the tourism industry are responsible for making a tourist destination attractive and for providing amenities and accessibility to enrich the tourists' experience. Air Transport has a major role to play in promotion of tourism in a vast country like India. No-frill airlines are helping to reach remote tourist destinations of India. This can be accomplished just if airlines make out their execution proficiency gap with bench-marked aircrafts. This research evaluates the outcome of efficiency of low-cost airlines in India using Data Envelopment Analysis (DEA). In this study, three output variables and three input variables are used. In this context, the input variables are representing the independent variables and the output variables representing the dependent variables. DEA is used to compute and compare the efficiency of low-cost airlines in India. The results of the analysis indicate that the technical and total efficient airlines using additive DEA techniques and scrutinize the slack and surplus variables of inefficient airlines and also to assess the proper utilization of their resources with the reference airlines. Finally to compute the ranking of all DMU's on the basis of total efficiency technique applying super efficiency technique.

Keywords—efficiency; low-cost airlines; additive data envelopment analysis (DEA); super efficiency technique; India

INTRODUCTION

The air transportation plays very important role in the expansion of the economy, inspiring affairs among the countries and facilitating international economic relations. At the same time, its economic well-being depends on the state of the world economy. The growth has been accredited to globalization of the industry driven by market deregulation and open skies agreement. Deregulation nurtured the growth of No-frill airlines (LCC) in the domestic market (Hannon, 2009). No-frill airlines have brought large reductions in price and large increases in the number of seats available. However, Borenstein (1989) finds that high levels of route and hub concentration correlated with higher airfares. Thus, the no-frill airline has become the new choice for travelers since 1990s in US and has become more favourite in Europe in early 2000. This model has commenced in India and popular in 2003. Presently, no-frill airlines fly almost every short-haul flights. The trend is common in most of the regions of the world including Asia.

The target of any organization is to build the yield, diminish costs, and get a pragmatic return of investment. These destinations can be accomplished by enhancing effectiveness. Agarwal et al., (2002) described the meaning of efficiency as the connection between the yield created by a generation or an administration framework and the info gave to make this yield. Efficiency comprehensively identifies with the proficient and compelling utilization of the current assets (land, capital, labor, material, energy, and so forth.) inside the requirements characteristic in the matter of delivering products or administrations. Profitability, hence, is suggested in each monetary action and principally remains for delivering an ever increasing number of yields from fewer and fewer assets. It is dictated by separating the yield by the information. At the point when efficiency of two firms is analyzed, the more beneficial firm creates more yields with a similar info or it delivers a similar yield with lesser information. It is indispensable to evaluate and screen the profitability of associations consistently to check how much data sources are used during the time spent getting wanted yields. Efficiency assessment is basic in an service industry like aviation. Efficiency enrichment is the fundamental capacity of management. The aviation industry is in an unusual circumstance.

Hence management of aviation companies should make quick strides for the productive and successful use of the accessible assets for most extreme yield. It is in fact a reality that aviation is the indicator of financial activity. With the undeniable trends blowing over the world and globalization turning into an acknowledged wonder, ensuing changes in the social and monetary condition will influence, and are influenced by, the flight. At present, air transport is the prime method of transportation. The ease of convenience, suppleness of process and consistency has earned air transport a progressively higher share of passenger transport mode. The passenger carried by air transport is rising rapidly. Because of privatization the offer of national transporters has declined to meet the incremental traveler activity request. In this study, the exhibitions of domestic low-cost airlines in India have been assessed for the year 2007 - 2008 to 2015 – 2016 utilizing DEA structure.

The objectives of the research is to bring out the assessment of efficiency of low-cost airlines in India using Data Envelope Analysis (DEA), which will assist to identify about the efficient airlines and inefficient airlines during the mentioned time framework. The study will provide the slack of variables and also will propose to proper utilization of their resources with the reference airlines. To get to main principle of this study, subsequent two objectives are concerned:

1. To study the effectiveness of low-cost airlines in India.
2. To examine the slack of variables of inefficient airlines and also to assess the proper utilization of their resources with the reference airlines.

1. LITERATURE REVIEW

DEA is a numerical program for estimating execution proficiency of associations famously named as decision-making units (DMUs) which change over numerous contributions to different outputs. The DMU can be of any kind, for example, producing units, various schools, banks, hospitals, firms and so on. DEA measures the execution productivity of these kinds of DMUs, which share a typical trademark that they share non-benefit association where the estimation is troublesome (Gabreil Tavers, 1978-2001). Late years have seen an incredible assortment of uses of DEA for use in assessing the exhibitions of a wide range of sorts of elements occupied with a wide range of exercises in a wide range of settings in a wide range of nations. These DEA applications have utilized DMUs of different structures to assess the execution of substances, for example, hospitals, US Air Force, colleges, urban areas, courts, business firms, and others, including the execution of nations, locales, and so on. Since it requires not very many suspicions, DEA has additionally opened up potential outcomes for use in cases which have been impervious to different methodologies in light of the complex (frequently unidentified) nature of the relations between the numerous information sources and various yields engaged with DMUs. Since DEA was first presented in 1978 in its present shape, specialists in various fields have immediately perceived that it is an incredible and effectively utilized system for displaying operational procedures for execution assessments. In beginning article, (Charnes et al.,1978) portrayed DEA as a numerical programming model connected to observational information gives another method for acquiring experimental evaluations of relations –for example, the generation capacities and additionally proficient creation plausibility surfaces – that are foundations of present day financial matters. Schefczyk (1993) looked at the operational execution of 15 airlines and presumed that high operational execution is a key factor of high productivity. Meryem et al. (2000) analyzed the determinants of proficiency in the European aviation industry. Lee and Worthington (2010) decided if the incorporation of LCCs (low-cost carriers) in a dataset of global and local aircrafts affected the productivity scores of alleged 'esteemed' and purportedly 'proficient' carriers. Merkert and Hensher (2011) utilized a two-stage DEA way to deal with demonstrate that carrier estimate and the quantity of various flying machine families in the fleet impact sly affects three kinds of aircraft efficiencies: technical, allocate, and cost. Gramani (2011) breaks down the operational and monetary efficiencies separate by contrasting three noteworthy Brazilian airlines and two noteworthy American airlines. The creator utilizes a two-stage DEA approach utilizing just operational factors to assess the operational effectiveness in the main stage, and utilizing the operational productivity and budgetary factors to locate the money related proficiency on the second stage. Joe Zhu (2011) estimated carrier execution utilizing a two-arrange process. In the principal arrange, assets (fuel, salaries, and different components) are utilized to keep up the fleet size and load factor. In the second stage, the armada size and load factors create income. The model utilized is known as the brought together productivity show where two phases are utilized to streamline execution at the same time. Albeit various papers on DEA exist, however examine papers utilizing DEA on Indian aircraft part is extremely constrained. A.K. Singh (2011) took a shot at Indian domestic airlines and assessed its operational proficiency utilizing DEA. Different proficiency measures were evaluated utilizing DEA with freely accessible information on an agent test of 11 airlines. The investigation uncovered that just a single carrier Indigo has the most extreme level of relative effectiveness (100%) out aggregate 11 domestic airlines while Jet Airways has relative proficiency of 99%. Go Air and Indian Airlines has relative effectiveness of 95.6% each.

2. RESEARCH METHOD

To examine the effectiveness of low-cost airlines in India and to get the slack values of inefficient DMUs the additive data envelopment analysis model used in the analysis and details are given below.

1. Additive DEA models using VRS Technique [Technical efficiency]

Put forward by Charnes, Cooper and Rhodes (1978) advantage from the idea of productivity proposed by Farrell (1957), the DEA is a linear programming based method which empowers estimation of comparative efficiencies of decision making units (DMUs) underway procedures where information sources and outputs are estimated by a few unique scales or with various units of estimation.

In DEA models for estimating input-oriented technical efficiency, the goal is to get all contributions at a similar rate to the degree conceivable without diminishing any output. The output-oriented DEA models think about the conceivable output increases while keeping the present levels of inputs. An additive DEA model considers conceivable information diminishes and in addition output increments all the while in the feeling of vector advancements. The additive models selected are (Cook and Zhu, 2005: 12):

$$Max\ Z_0 = \sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+$$

Subject to

$$\sum_{j=1}^{N} y_{rj\ \lambda_j -} S_r^+ = y_{r0}$$

$$\sum_{j=1}^{N} x_{ij\ \lambda_j +} S_i^- = x_{i0}$$

$$\sum_{j=1}^{N} \lambda_j = 1$$

$$\lambda_j,\ S_j^-,\ S_r^+ \ \geq 0$$

i = 1, 2,….., m r = 1, 2, …..n j = 1, 2, …..N

In additive model, for the DMU to be effective (Green et al., 1997):

Z_0 = 0, in other words,

$$\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ = 0$$

It is required. Otherwise, the nonzero optimal S_i^{-*} identifies a surplus consumption of i^{th} input, and nonzero best possible S_r^{+*} identifies a deficit in the r^{th} output. Clearly, the estimated DMU is competent if all slack variables in the optimal solution are zero in problem.

2. Additive DEA models using CRS Technique [Total efficiency]

In DEA models for estimating input-oriented technical effectiveness, the goal is to get all contributions at a similar rate to the degree conceivable without lessening any output. The output situated DEA models think about the conceivable output enlargements while keeping the present levels of inputs. An additive DEA display considers conceivable info diminishes and additionally output increments at the same time in the feeling of vector enhancements. The added substance models chose are (Cook and Zhu, 2005: 12):

$$Max\ Z_0 = \sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+$$

Subject to

$$\sum_{j=1}^{N} y_{rj\ \lambda_j -} S_r^+ = y_{r0}$$

$$\sum_{j=1}^{N} x_{ij\ \lambda_j +} S_i^- = x_{i0}$$

$$\lambda_j,\ S_j^-,\ S_r^+ \ \geq 0$$

i = 1, 2,….., m r = 1, 2, …..n j = 1, 2, …..N

In additive model, for the DMU to be effective (Green et al., 1997):

$Z_0 = 0$, in other words,

$$\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ = 0$$

It is required. Otherwise, the nonzero optimal S_i^{-*} identifies an excess utilization of i^{th} input, and nonzero optimal S_r^{+*} identifies a deficit in the r^{th} output. Clearly, the estimated DMU is competent if all slack variables in the best solution are zero in problem.

3. Additive DEA models using CRS Technique [Super efficiency]

In DEA models for estimating input-oriented technical proficiency, the goal is to get all contributions at a similar rate to the degree conceivable without decreasing any output. The yield situated DEA models think about the conceivable yield increases while keeping the present levels of inputs. An additive DEA display considers conceivable info diminishes and yield increments all the while in the feeling of vector improvements. The additive models selected are (Cook and Zhu, 2005: 12):

$$Max\ Z_0 = \sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+$$

Subject to

$$\sum_{j=k}^{N} y_{rj\,\lambda_j -} S_r^+ = y_{r0} \quad k \neq j$$

$$\sum_{j=k}^{N} x_{ij\,\lambda_j +} S_i^- = x_{i0}$$

$$\lambda_j,\ S_j^-,\ S_r^+ \geq 0$$

i = 1, 2,….., m r = 1, 2, …..s j = 1, 2, …..N k = 1,2,….N

In additive model, for the DMU to be effective (Green et al., 1997):

$Z_0 = 0$, in other words,

$$\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ = 0$$

It is required. Otherwise, the nonzero optimal S_i^{-*} identifies an excess utilization of i^{th} input, and nonzero optimal S_r^{+*} identifies a deficit in the r^{th} output. Clearly, the evaluated DMU is efficient if all slack variables in the optimal solution are zero in problem.

3. INPUT AND OUTPUT VARIABLES USED IN THE ANALYSIS

Data of a range of considerations related to the technological and economic vigor of the airlines were composed. An effort was made to study the scientific effectiveness and total efficiency, by relating to the use of input and output variables. In this study, the "Revenue Passenger Kilometers Performed" (RPKM), "Tonnes Kilometers Performed" (TKP) and "Aircraft Utilization" (AU) are used as output variables, while the "Fleet Size" (FS), "Total Employees" (TE) and "Total Operating Expenses" (TOE) are used as the input variables. In this study, the input variables indicate the independent variables and the output variables are the dependent variables. The DEA has occupied to estimate the technological and total efficiency and also to get the slack values of the inefficient airlines. Effectiveness of each low-cost airline in comparison with other low-cost airlines was projected. This presented an obvious thought concerning performance of various low-cost airlines for the specific time perspective.

4. RESULTS

The technical efficiency and total effectiveness values of the DMUs were computed using the additive model of the DEA. Scientific effectiveness values of the DMUs collectively with reference DMUs are shown in Table 5.1.

Table 5.1: Technical Efficiency Results

DMU	Max Z	S1	S2	S3	S4	S5	S6	Reference DMU
1	2859.32	1819.17	1040.15	0.00	683.30	40.07	0.00	W7=0.79 W9=0.21
2	1216.13	1051.48	163.74	0.92	0.00	17.60	8826.52	W3=0.87 W9=0.14
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
4	733.30	733.30	0.00	0.00	862.39	106.72	0.00	W7=0.56 W12=0.63E-01 W13=0.37
5	5645.13	5644.95	0.00	0.18	0.00	16.59	6105.85	W3=0.69 W9=0.27 W25=0.38E-01
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
10	1520.67	1472.57	48.09	0.00	676.93	101.30	0.00	W7=0.97E-01 W9=0.49
11	1147.73	966.37	181.37	0.00	0.00	105.12	12077.29	W8=0.72 W12=0.25 W27=0.29E-01
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
14	16631.0	15508.09	1118.49	4.45		160.09	5043.23	W9=0.19 W12=0.81
15	8119.16	8075.70	37.13	6.34	265.63	45.05	0.00	W12=0.85 W27=0.15
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
17	21613.35	20387.85	1215.60	9.90	735.80	241.51	0.00	W12=0.94 W27=0.59E-01
18	18298.95	17820.84	472.66	5.46	541.59	69.79	0.00	W12=0.67 W27=0.33
19	0.00	0.00	0.000	0.00	0.00	0.00	0.00	Efficient
20	32746.29	31445.85	1286.646	13.80	1394.49	284.83	0.00	W12=0.91 W27=0.90E-01
21	24468.19	24254.27	209.3648	4.56	1756.14	186.29	0.00	W12=0.50 W27=0.50
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
23	27369.56	26876.11	493.45	0.00	0.00	130.13	0.00	W8=0.31 W9=0.32 W27=0.82E-01
24	15943.49	15385.01	552.81	5.67	1492.40	128.51	0.00	W12=0.27 W27=0.73
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient
26	22025.24	19861.50	2153.44	10.31	0.00	145.64	867.46	W9=0.41 W12=0.59
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Efficient

Table 5.1 shows that, 12 DMUs (3, 6, 7, 8, 9, 12, 13, 16, 19, 22, 25, and 27) are technically efficient and rest 15 DMUs are not. In other words, under existing environmental conditions, while it is possible to obtain better indicators with their data inputs, these airlines, due to management inaccuracy, have not been able to utilize their technical resources effectively and not been efficient.

After calculating the technical efficiency, the total efficiency of the DMUs was determined under constant returns to scale (CRS), the results are shown in table 5.2.

Table 5.2: Total Efficiency Results

{	Max Z	S1	S2	S3	S4	S5	S6	Reference DMU
1	2859.32	1819.165	1040.15	0.00	683.29	40.07	0.000	W7 =0.79 W9 =0.21
2	3749.56	2997.450	747.73	4.38	0.00	10.21	3688.112	W9=0.58
3	1416.25	770.4868	644.64	1.12	156.99	0.00	0.000	W7=0.19 W9=0.45
4	1347.35	1347.353	0.00	0.00	784.33	99.70	0.000	W7=0.61 W9=0.10 W13=0.33
5	7858.65	7390.321	465.36	2.98	0.00	11.30	1719.161	W9=0.64
6	0.00	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
7	0.00	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
8	0.00	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
9	0.00	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
10	2170.23	2170.292	0.00	0.00	922.24	127.99	0.000	W7=0.20E-01 W9=0.61 W13=0.12
11	3034.3	2882.132	152.17	0.00	0.00	111.81	16339.14	W8=0.53 W9=0.66
12	0.00	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
13	0.000	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
14	17528.49	17528.49	889.67	6.25	0.00	157.25	11756.49	W9=1.35
15	16598.62	16589.81	0.00	8.80	0.00	26.40	4761.012	W9=1.83 W12=0.13E-01
16	0.000	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
17	27373.34	26096.88	1262.71	13.76	0.00	168.76	0.000	W7=0.48E-01 W9=1.48
18	34955.79	34254.16	693.43	8.20	0.00	36.13	1323.676	W9=2.31
19	0.000	0.000	0.000	0.00	0.00	0.00	0.000	Efficient
20	39850.02	38178.98	1656.23	14.82	0.00	135.96	0.000	W7=0.44 W9=1.29
21	48829.68	47702.01	1125.29	2.37	0.00	22.49	0.000	Efficient
22	0.00	0.000	0.00	0.00	0.00	0.00	0.000	Efficient
23	31613.92	31126.50	487.43	0.00	0.00	140.17	5028.555	W8=0.11 W9=1.27
24	49971.60	48400.25	1567.75	3.60	0.00	11.78	0.000	W7=0.51 W9=3.10
25	0.00	0.000	0.00	0.00	0.00	0.00	0.00	Efficient
26	22680.01	20681.90	1986.49	11.61	0.00	143.57	5765.31	W9=1.26
27	42046.82	41467.12	579.70	0.00	0.00	45.81	956.83	W8=0.68 W9=3.74

The ten airlines which are technically efficient (DMU 6, 7, 8, 9, 12, 13, 16, 19, 22 and 25) are also efficient in total. The only two airlines (DMU 3, 27) are technical efficient but not in total efficient. The reason why airlines do not show total efficiency is that they are inactive in fit scale sizes.

Table 5.3: Super Efficiency Results

Sl. No.	DMUs	Super Efficiency Score
1	DMU 6	197.5828
2	DMU 7	7.871464
3	DMU 8	309.4109
4	DMU 9	288.2129
5	DMU 12	2.329243
6	DMU 13	1.273908
7	DMU 16	0.000000
8	DMU 19	3369.989000
9	DMU 22	2765.270000
10	DMU 25	0.000000

Table 5.4: Ranking of 27 DMUs after Super Efficiency

Sl. No.	DMUs	Efficiency Score after Super Efficiency	Ranking	DM Name& Year
1	DMU16	0.0000000	1	Jetlite2012-2013
2	DMU25	0.0000000	1	Jetlite2015-2016
3	DMU13	1.273908	2	Jetlite2011-2012
4	DMU12	2.329243	3	Indigo2010-2011
5	DMU7	7.871464	4	Jetlite2009-2010
6	DMU6	197.5828	5	Indigo2008-2009
7	DMU9	288.2129	6	Indigo2009-2010
8	DMU8	309.4109	7	Spicejet2009-2010
9	DMU22	2765.27	8	Jetlite20014-2015
10	DMU19	3369.98900	9	Jetlite2013-2014
27	DMU24	49971.60	26	Indigo2014-2015

The inefficient DMU can be made as efficient if we consider the reference weight as given. Out of 27 DMUs the most inefficient DMU is DMU 24 i.e. Indigo (2014-15) now to make DMU 24 efficient if we can control input & output by using reference weights given to maintain MPSS [Most Productive Scale Size] before super efficiency.

5. CONCLUSION

The two airlines namely Jetlie 2012-13 and Jetlite 2015-16 are technically and totally efficient comparing with other eight airlines which we get using Super Efficiency after adjusting the reduced cost for all surplus variables for all ten efficient DMUs . The reason why other eight airlines show efficiency but not super efficient hence they are inactive in fit scale sizes.

In table 5.4, DMU 24 which is indigo 2014-15; that needs to change its input and output the most. The changes that should be made for Indigo 2014-15 with respect to two airlines namely Jetlie 2012-13 and Jetlite 2015-16.

2012-13	Jetlite(16)	22274.8	1019	15	3387.6	294.5	63068
2015-16	Jetlite(25)	11154.10	740	8	2125.3	190.9	34119
2014-15	Indigo(24)	123578.64	10536	94	24957.1	2399.4	324875.0

Using the above input and output table for two most efficient and one most inefficient DMU the changes of the inputs and outputs are given below:

1. Input 1 for DMU24 lies between 11154.1 to 22274.8
2. Input 2 for DMU24 lies between 740 to 1019

3. Input 3 for DMU24 lies between 8 to 15
4. Output 1 for DMU24 lies between 2125.3 to 24957.1
5. Output 2 for DMU24 lies between 190.9 to 2399.4
6. Output 3 for DMU24 lies between 34119 to 324875

If all the three inputs as well as outputs of DMU24 satisfy the upper conditions then we can conclude that the DMU24 is trying to be efficient DMU.

6. FUTURE SCOPE

Further we can use factor analysis method to validate the ranking obtained by DEA additive method. In this paper we consider three inputs and three outputs from the domain knowledge of airlines which can be tested by Structural Equation Modeling and make inefficient DMU to efficient we can apply Fuzzy DEA techniques.

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