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A COMPARITIVE ANALYSIS OF AIRLINES EFFICIENCY: EVIDENCE FROM MIDDLE EAST AND NORTH AFRICA

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Abstract

Efficiency is a concept that has a long history in the sciences and its measurement and analysis is a vital importance for firms to achieve their best performance. Hence, the purpose of this study is to evaluate efficiency of airline members of international air transport association (IATA) in Middle East and North Africa (MENA) using non-parametric data envelopment analysis method. Data collected by statistical annual reports available in official airlines and air transport authorities websites for 20 airlines from 14 countries. These airlines have analyzed through three outputs including number of passenger carried, revenue passenger kilometre, revenue tone kilometre and three inputs namely available seat kilometre, available tone kilometre and size of fleet using two input orientation approaches of constant return to scale and variable return to scale. The results reveal that the average of efficiency in CRS and VRS models are 90% and 98% respectively. Moreover, according to nationals ranking based on airlines ratios for scale efficiency, United Arab Emirates and Sudan have gained superior and lowest situation respectively.

Keywords: Efficiency, Data Envelopment Analysis, Airlines, Air Transportation

Topic Groups: Production and operations management

1. INTRODUCTION

Transportation is a basic need of human society in which air transport is the youngest, most modern and most secures mode of transportation. Air transport industry has growing share of cargo and passenger than other modes due to ease of access, high speed carrying, financial benefits and high reliability. Hence Over the past decades, growing of the air transport demand, the technological progress, the strong investments in this field and the aviation

deregulation have determined a rapid development of air transportation (Coli et al, 2008). The airline industry plays a crucial role in the economy in multifaceted dimensions. First, it enhances globalization and increases economic cooperation among nations. Second, it facilitates international movement of goods, services and factors of production. Third, it plays direct role by providing job opportunities and indirectly by creation of opportunities for travel and hospitality sector of an economy. Moreover, the airline industry is different from other industries in many cases that variety of air and ground operations, high sensitivity to economic and political developments, high costs of production factors and multilateral strategic cooperation between different companies from different parts of the world are among these cases (Ahmad & Mukhtar-khan, 2011). These features have intensified competition in the airline industry in recent years and as a result, reduce the ability of companies to withstand prolonged periods of operational inefficiencies. Thus in recent years, airlines have attempted to consolidate their activities, make modern fleet to more fuel controlling and reduce costs thereby achieving maximum efficiency to increase competitiveness and to achieve an acceptable return on investment. So, productivity and efficiency are very important in the operating performance of each airline nowadays. Regarding to importance of airlines' efficiency, numerous studies have been done in this area that have been studied airline efficiency at national or international level (Schefczyk, 1993; Fethy et al, 2000; Wong and Chen, 2005; Barbot et al. 2008; Hong and Zhang, 2010; Lee and Worthington, 2010; Zhu, 2011; Powell, 2012; Arjomandi and Seufert, 2013). However, research on measuring the efficiency of airlines in the MENA region has less been observed. Nevertheless, air transport industry in the Middle East and North Africa is one of the fast growing and high profitability industries in the global economy. It was achieved by some prerequisites such as continual econometric monitoring and high average efficiency in the airlines. Therefore the purpose of this study is to evaluate efficiency of 20 airlines member of the International Air Transport Association (IATA) from 14 countries in the MENA using data envelopment analysis method.

2. DATA ENVELOPMENT ANALYSIS

The goals of any enterprise are to increase output of goods or services, reduce costs and then achieve a reasonable return on investment and favourable competitive advantage. These objectives can be achieved through improved efficiency. Efficiency defines broadly as effective use of available resources in the production of goods or services.The measurement and analysis of efficiency shows how the units can utilize resources in order to achieve the best performance and increased production. One of the efficiency measurement models is DEA. This method was presented by Charnes, Cooper and Rhodes (1978). In this model, each airline is consider as a decision making unit (DMU) that evaluate through two sets of input and output factors that related to the operation performance. Input factors are defined as limited amount of resources to produce a maximum amount of output and the output factors are the consequences and outcomes of a manufacturing or service system as the result of utilizing limited of resources.

The DEA technique uses linear programming that determines frontier efficiency of different units as standard performance. Then efficiency of each unit evaluates by this standard and the score of each unit is determined. Moreover, it can be possible using data envelopment analysis to recommend company or companies as a reference for each of the inefficient airlines that show optimal structure of inputs and outputs.

In this study, we use CRS and VRS models for evaluating efficiency to gather information about technical and scale efficiencies for each airline. Technical efficiencies calculated from CRS (CCR: Equation 1) and VRS (BCC: Equation 2) modes and scale efficiency is equal with divided by these two measures.

$$Max \sum_{r=1}^{s} u_r y_{rj} \quad (1)$$

$$s.t.$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$$

$$\sum_{i=1}^{m} v_i x_{ij} = 1$$

$$u_r \geq 0, r = 1, 2, \dots, s;\ v_i \geq 0, i = 1, 2, \dots, m; j = 1, 2, \dots, n\ .$$

$$Max \sum_{r=1}^{s} u_r y_{rj} + w \quad (2)$$

$$s.t.$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + w \leq 0$$

$$\sum_{i=1}^{m} v_i x_{ij} = 1$$

$$u_r \geq 0, r = 1, 2, \dots, s;\ v_i \geq 0, i = 1, 2, \dots, m; j = 1, 2, \dots, n, w = free.$$

Where y_{rj} represent scale of output r of airline j, x_{ij} is amount of input i of airline j, u_r show weight of output r and v_i indicate weight of input i. In equation 2, w demonstrates increasing proportion of the output per increasing input. It means that w>0, w<0 and w=0 represent increasing returns to scale, decreasing returns to scale and constant returns to scale respectively.

3. METHODOLOGY

The activity of airlines is carrying of passenger and cargo. Since rising input factors and decreasing output factors reduce the efficiency, we use the number of passenger carried, revenue passenger kilometre (RPK: multiplying the number of paying passengers by the number of kilometres that they carry), revenue tone kilometre (RTK: multiplying the number of tonnes of revenue load by the number of kilometres that they carry) as outputs and available seat kilometre (ASK: sum of the number of available seats for the carriage of paying passenger on each flight), available tone kilometre (ATK: sum of the number of tonnes available for the carriage of revenue load including passengers, freight and mail on each flight) and Fleet Size (the number of airplanes in the airline's fleet) as inputs. Using these indicators is also considered according to previous research on the efficiency of airlines. In this regard, we adopted Revenue Passenger Kilometer from Schefczyk (1993), Fethi et al (2000), Wong and Chen (2005), Barbot et al (2008), Hong and Zhang (2010), Lee and Worthington (2010), Zhu (2011), Sing (2011), Powell (2012), Revenue Tone Kilometer from Barbot et al (2008), Hong and Zhang (2010), Sing (2011)), Available Seat Kilometer from Wong and Chen (2005), Hong and Zhang (2010), Lee and Worthington (2011), Available

Tone Kilometer from Schefczyk (1993), Fethi et al (2000), Lee and Worthington (2011), Arjomandi and Seufert (2013) and Fleet Size from Barbot et al (2008), Zhu (2011), Sing (2011), Lee and Worthington (2011).

Due to the international study, the data related to 2010 that gathered through statistical reporting of Iran Civil Aviation Organization, Arab Air Carrier Organization, African Airlines Association, ATWonline and official airline websites. These data belong to 20 airlines from 14 countries of MENA region which their statistical performances were accessible (see table 1).

Table 1: Airline Names and IATA Designator

IATA Designator	Airline Name	IATA Designator	Airline Name
8U	Afriqiyah Airways	KU	Kuwait Airways
AH	Air Algerie	LN	Libyan Airlines
MS	Egyptair	W5	Mahan Air
EK	Emirates	ME	Middle East Airlines
EY	Etihad Airways	WY	Oman Air
GF	Gulf Air	QR	Qatar Airways
IR	Iran Air	RJ	Royal Jordanian
EP	Iran Aseman Airlines	SV	Saudi Arabian Airlines
R5	Jordan Aviation	SD	Sudan Airways
Y9	Kish air	TU	Tunisair

4. DATA ANALYSIS

According to the data, the average number of passengers carried by the airline companies is about 6 million people per year that Emirates and Jordan aviation have highest and lowest share respectively. For other factors, Emirates has superior position. In addition, lowest performance in RPK belongs to Sudan airways and minimum of other indexes relate to Jordan aviation.

Table 2: Statistical Analysis of Indexes

Factors	Average	Maximum	Minimum	Standard Deviation
Y1	5992.750	31422	295	7430.347
Y2	17719.370	143660	683.864	32693.850
Y3	2474.569	21779	64	5000.297
X1	23825.149	178581	1202	41167.889
X2	3997.261	31396	108	7402.039
X3	41	148	12	37

Note: Y1 (thousand), Y2, Y3, X1, X2 (million)

According to CRS model, it is possible to improve overall airline's efficiency about 10% by reducing the number of aircrafts, ASK and ATK. But the ability based on the VRS model is about 2 percent.

Table 3: Total Results of Airlines Efficiency

Efficiency	Average	Maximum	Minimum	Number of Efficient Airlines	Percentage of Efficient Airlines
CRS	0.902	1.000	0.641	6	30
VRS	0.977	1.000	0.851	14	70
Scale	0.923	1.000	0.641	6	30

The findings show 6 airlines are efficient according to CRS model. Regarding to VRS, 14 airlines are at optimal level. Moreover, Sudan airways and Libyan Airlines have least efficiency scores and 6 airlines including Emirates, Etihad Airways, Iran Aseman, Kish Air, Mahan and Oman Air are efficient in both models. Libyan Airlines, Middle East Airlines, Qatar Airways, Royal Jordanian, Air Algerie and Gulf Air are inefficient in both models.

Table 4: Efficiency Rates of Airlines

Airlines	CRS	VRS	Scale
Afriqiyah Airways	0.793	1.000	0.793
Air Algerie	0.876	0.949	0.924
Egyptair	0.897	1.000	0.897
Emirates	1.000	1.000	1.000
Etihad Airways	1.000	1.000	1.000
Gulf Air	0.950	0.958	0.992
Iran Air	0.934	1.000	0.934
Iran Aseman Airlines	1.000	1.000	1.000
Jordan Aviation	0.724	1.000	0.724
Kish air	1.000	1.000	1.000
Kuwait Airways	0.947	1.000	0.947
Libyan Airlines	0.744	0.851	0.874
Mahan Air	1.000	1.000	1.000
Middle East Airlines	0.83	0.995	0.834
Oman Air	1.000	1.000	1.000
Qatar Airways	0.915	0.916	0.999
Royal Jordanian	0.876	0.880	0.995
Saudi Arabian Airlines	0.937	1.000	0.937
Sudan Airways	0.641	1.000	0.641
Tunisair	0.966	1.000	0.966

Since the research models are input oriented, inefficient airlines can come close to the efficiency frontier by reducing available seat kilometre, available tone kilometre and the number of aircraft. So, available and optimal amounts of the inputs have been shown in table 5 based on CRS and VRS models. The findings show, more reforms are required for the industry according to CRS model.

Table 5: Available and Optimal Values of Efficiency

Factors	Available	CRS		VRS	
		Optimal	% Chang	Optimal	% Chang
X1	476502.980	454434.986	-4.63	465774.384	-2.25
X2	79945.222	73641.739	-7.88	76902.715	-3.81
X3	825	766	-7.15	812	-1.58

Note: X1, X2 (million)

5. DISSCUSION AND CONCLUSION

The air transport industry has been regarded by researchers in the various fields of study as a result of cultural, political and economic effects in each country. One of the most important fields is econometrics and measuring the efficiency of airlines. Productive efficiency improves firm ability to sell its product and services at a price at least equivalent to the cost required to produce them. It can increase airlines competitiveness and leads to access capital required for development of services and markets more widely through internal and external resources. Hence, regarding to the importance of airlines' efficiency, in this study attempted to evaluate relative efficiency of 20 airline members of the International Air Transport Association in the MENA region from 14 countries.

Application of DEA in CRS model show the average of industry efficiency is 90.2%. Therefore it is possible to improve this rate up to 9.8% by reducing 4.63% in available seat kilometre, 7.88 in available tone kilometre and 7.15 in number of aircraft. In this model, according to the highest performance among other inefficient airlines, largest amount of decline in two available seat kilometres and available tonne Kilometres belong to Qatar Airways. Also, greatest part of reducing fleet allocated to Egyptair and the Sudan airways. In this model, 6 airlines have optimal performance, 6 companies are above average of efficiency and 8 companies are below. In addition, UAE and Oman have highest efficiency and Sudan has acquired weakest performance among the countries.

The result by VRS model represent the efficiency of the industry is 97.7 that represent higher level compared to CRS. Thus, it is possible to achieve optimal levels of performance with fewer changes by reducing 2.25, 3.81 and 1.58 in ASK, ATK and the number of aircraft respectively. According to the model, these reforms need to be implemented in 6 airlines that include Air Algerie, Gulf Air, Libyan airlines, Middle East Airlines, Qatar Airways and Royal Jordanian. However, as the highest performance in terms of operating performance among inefficient airlines, Qatar Airways needs to reduce wider to all three outputs available seat kilometres, available tonne kilometres and the number of aircraft at a rate of 55.9, 76.89 and 46.15 percent of total change.

The result of scale Efficiency level show by assumption 6 performance parameters namely ASK, ATK and the number of aircraft to produce RPK, RTK and the number of passenger, the average of efficiency of airlines is 92.3 percent. It means the industry is lower of the optimal performance at about 7.7 percent that can be improved. In this regard, 6 airlines have allocated resources efficiently, 8 airlines are above the average of efficiency and other airlines are below the average of efficiency. Finally, the results show that Emirates, Etihad, Oman Air, Mahan, Iran Aseman and Kish Air are efficient in both models that represent better performance among others.

Like other studies, this paper has affected by some limitations. It means the statistical data gathered from various air transport authorities that were observed some contradictions. So data could be tested further validity if we had access to all the information from one source. In addition, the lack of access to new data and more performance indicators are other limitations that could leads to more accurate results by the study.

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