Airline Efficiency Performance in the Turbulent Period Before and After Economic Crisis

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The purpose of the paper is to analyze the operational performance of a set of 17 airlines that operate across Europe in 2008 and 2012, the period that imposed a burden of challenge to airline industry due to severe global economic crisis occurred in 2008. In addition to major carriers in Europe, the sample contains several airlines located in Central and South-East Europe that have been not been broadly investigated in the relevant literature. The study utilizes the standard DEA approach with the inputs consisting of several subsets (resources, costs, capacity, etc), while outputs encompass productivity and economic indices. The results of the model reveal that most of the South-East and Central European airlines are inefficient relative to their western counterparts. Still, these large western airlines tend to be inefficient compared to the major low-cost carriers operating in Europe. Moreover, the model enables obtaining insights into the cause of inefficiency of the airlines with particular implications for improvement in the future. Despite severe economic crisis, the model shows that airlines tend to recover faster than one could even expect it.

Key words: airline efficiency, DEA method, global economic crisis

1. INTRODUCTION

Airline industry is featured by highly cyclical trends, with the periods of downturns followed by the periods of recovery and rising demand for air travel. In the wake of prolonged world-wide recessions and skyrocketing oil prices, the airline industry lost \$16 billion in 2008 and \$9.9 billion in 2009 [1]. Although this post 2008 global recession crisis, at first glance, seemed to be less severe than the previous one followed the terrorist attacks in the US on September 11th 2001, it caused the immediate collapse in global demand for air travel that had not been recorded since World War II. The global economic crisis coincided with the drop in demand occurred as a part of the cyclical downturn, jointly exacerbating the financial performance of the global airline sector more severe than most analytics

could have anticipated. In such circumstances, most airlines well armoured by the experienced gained during the events of 2001/2003, grounded their capacity for the short term in order to reduce the cost induced by lacking demand. All these circumstances profound the gap between those airlines that successfully manage the crisis periods acquiring adequate business model and those less successful that business model were not able to sustain profitable growth. All these events caused significant changes in the structure of the European industry both as a reflection of these shocks, but also as a result of on-going market forces [2].

For example, two large carriers, British Airways and Iberia, signed merger agreement in 2011 and created one of the world's biggest airlines group. Meanwhile, Central and Eastern European national carriers such as LOT Polish Airlines and CSA Czech Airlines struggled to survive in new liberalized market conditions, while some of them such as Slovak Airlines, Lithuanian Airlines and Hungarian Malev ceased operations in 2007, 2009 and 2012 due to persistent financial problems. On the other hand, several low-cost airlines, above all Ryanair and EasyJet, continued

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to record positive growth in terms of both number of passengers and profit despite economic turmoil. Finally, the uprising Middle-East carriers saw tremendous expansion in last decade imposing a burden of challenge to their competitors, especially those major long-haul airlines in Europe. Most notably is the development of Dubai's home carrier Emirates Airlines that not only serve the primary hubs in Europe, but also a number of secondary airports across continent [3]. As the result of these newly arisen developments on the market, it is reasonable to expect that relative efficiency of airlines has been changed over observed period of time.

This paper considers airline efficiency changes in 2008. and 2012. by employing Data Envelopment Analysis (DEA) with the particular focus on the impacts of the event of global recession looking at a large sample of 17 airlines that operate in Europe.

The sample contains the airlines that significantly differ in terms of four core aspects such as their size (large legacy carriers vs. smaller legacy carriers), dominant business models (full service carriers vs. low-cost carriers), geographical location (European carriers vs. Middle Eastern carrier) and time adjustment to new market conditions (carriers operate at early liberalized markets vs. carriers operate at lately liberalized market).

The paper is organized as follows. After the Introduction part, Section 2 reviews the literature on DEA methodology application in measuring airline efficiency. The Section 3 provides the brief information on key traffic statistics that serves as a baseline to classify the airlines into meaningful groups for the sake of easier interpretations of results. The data and results are given in Section 4. Finally, Section 5 concludes the paper.

2. LITERATURE REVIEW

DEA is non-parametric mathematical technique for measuring relative efficiency of decision making units (DMU) that does not require any explicit functional relation between inputs and outputs. Initially proposed by Farrell [4], it allowed the evaluation of efficiency based on the multiple inputs and only a single output.

The model was further extended by Charnes et al. [5] that proposed the so-called CCR model that enables the multiple outputs in the model, but assumed the constant return to scale. Banker et al. [6] proposed the BCC model to deal with variable return to scale (VRS). Since then, the various modification of standard DEA method has been applied in the large number of transportation field.

DEA method has gained much attention in airlines performance benchmarking so far. Since the first pioneering work in investigating airline efficiency carried by Schefczyk (1993) as stated in Jain and Natarajan [7], abundant of papers emerged in relevant literature treating different set of airlines in different timeframes combining DEA with other methods. In addition to DEA method, Good et al. [8] employed Cobbe-Douglas econometric model to examine the efficiency of 8 largest European and 8 largest American airlines during the period 1976-1986, which coincides with the process of deregulation and liberalization of the markets.

The recent studies includes work of Scheraga [9] who measured the efficiency of 38 airlines across different continents for 1995 and 2000. and found minor changes in their relative efficiency. Greer [10] examined changes in the productivity of the major United States passenger airlines from 2000. to 2004. by employing both DEA and the Malmquist productivity index and found a significant improvement in productivity of observed carriers. Barbot et al. [11] compared the efficiency and productivity of 41 international airlines across four regions (Europe and Russia; North America and Canada; China and North Asia and Asia Pacific; Africa and Middle East) that encompass both full-service carriers and low-cost carriers by applying two different methodologies – DEA and Total Factor Productivity (TFP).

The results revealed that low-cost carriers were more efficient than full-service carriers. Barros and Peypoch [12] use DEA to evaluate the operational performance of 27 airlines, all members of Association of European Airlines (AEA) from 2000 to 2005 observing the increase in efficiency over observation period. Moreover, Lee and Worthington [13] determined whether the inclusion of low-cost airlines in a dataset of international and domestic airlines had an impact on the efficiency scores of so called "prestigious" and purportedly "efficient" airlines. They investigated the technical efficiency of 53 airlines in 2006. The findings reveal that most of the budget airlines are efficient relative to their more prestigious counterparts.

In addition to standard DEA methods, two-stage DEA has emerged as an appropriate tool to capture the effect of intermediate variables and has been widely employed in airline industry. For example, based upon development of Liang et al. [14], Zhu [15] employed the similar approach in airline industry and evaluated airline performance using a two-stage process. Merkert and Hensher [16] evaluated the key determinants of 58 passenger airlines by applying a two-stage DEA revealing that not only the size of airlines but also the fleet mixes of the size of aircrafts and the number of aircraft

families have an impact on technical, allocative and cost efficiency.

From an academic perspective, the contribution of this paper resides in the thorough selection of inputs in standard DEA model and their careful classification as well as the sample characteristics. The airline efficiency is calculated based on several inputs that reflect the airline resources, costs structure, capacity and marketability, and single output describing financial and productivity aspects of airline's performance. The second contribution presents the inclusion of four airlines that operate at Balkan region which have not been subject of similar analysis in the past. The next section briefly describes the characteristics of the selected airlines.

2. CONTEXTUAL SETTINGS

As it was previously mentioned, the observed sample includes 17 airlines operating across Europe. Sixteen out of them are registered in Europe, while Emirates Airlines stands as middle-eastern carrier with meteoric expansion in Europe, as elsewhere. The aim was to include major European carriers, as well as their smaller counterparts, but also to include the representative of most successful low-cost carriers. The overall sample could be roughly split into following four sets:

- The first set encompasses the three largest European carriers which have moved towards some forms of cross-border consolidation (Lufthansa – Swiss International Air Lines forming LH Group with several other carriers; Air France – KLM, and, to a much lesser degree, British Airways – Iberia forming IAG group). As it can be seen from Figure 1a), these three airlines transported large number of passengers every year with few hundreds of aircraft in their fleets. In addition to merger process, these three groups of airlines have formed the alliances and permitted other airlines to fit into the wider industrial structure.
- The second set comprises two most successful European low-cost airlines, Ryanair and EasyJet that made revolutionary changes in European market by offering the affordable prices and thus attracted the large portion of price-sensitive travelers.
- The third set includes the airlines that can be roughly split into two distinct subsets. First subset consists of national full-service carriers significantly smaller in scope and size compared to the airlines from the first set (SAS and Finnair). In addition to these airlines, Air Berlin and Norwegian is also included in this subset as the airlines operate under similar market conditions. Although Norwegian is very often perceived as a company that promotes low-cost business model, there is the ample evidence that approves its hybrid business structure [17]. According to the same source, Air Berlin is characterized as full service airline. The second subset of this set comprises the airlines located in the countries of Central and South-East Europe that have undergone a profound transformation from a central planned to market based economy over the past 25 years. After accession the European Union in 2004, the national flag carriers of these countries (Polish LOT and Czech CSA Airlines) have faced many financial problems incurred as a result of ineffective management in state ownership as well as the fierce competition of low-cost carriers, new rivals on the market. Although smaller than their counterparts in Central Europe, the airlines formed after the break-up of Yugoslavia (Serbian Jat Airways, Croatian Croatia Airlines and Slovenian Adria Airways) passed throughout similar process additionally accompanied by political and economic unrest and ethnic war in 90's, the events that exacerbate the airlines' performance and their positions on the markets. Similar to these three carriers, Romanian national state-owned carrier, Tarom, has passed through turbulent period after the collapse of the communist regime in 1989.
- The fourth set is singleton including only Middle-eastern carrier Emirates Airline that had aggressive expansion at phenomenal average annual pace of 12.4% in the number of passengers in the period from 2010 to 2015. This carrier is considered as a "game changer" in airline industry as it brings conceptual changes and innovations in business model followed by Dubai's rapid economic growth [18]. Emirates focuses its business on "secondary-hub-secondary" strategy of connecting Europe's secondary airports with cities in Asia and Australia with only one transfer enabling it to enjoy a competitive advantage in travel time on a number of city pairs in comparison with European legacy carriers [3].

Figure 1 and 2 show some of the main feature of the airlines. For the simplicity of presentation and interpretation of data, the first, second and the fourth group are presented together in Figure 1 since they transported considerable number of passengers in 2012. Fig. 2 depicts the total number of passengers and their fleets solely for the third set of airlines.

As it can be observed from Figure 1, the airlines vary considerably in size, with LH Group being placed on the top of the list by the number of passengers exceeding 100 million, followed by AF-KLM that carried almost 80 million and IAG with slightly over 50

million in 2012. Figure 2 shows that Air Berlin, with almost 35 million passengers and SAS with over 25 million are the two largest carriers.

Figure 1 – Number of passengers and aircraft in the fleets in 2012, for the first, second and fourth sets of airlines Source: Data retrieved from airlines' websites

Figure 2 – Number of passengers and aircraft in the fleets in 2012 for the third set of airlines Source: Data retrieved from airlines' websites

The Central and South-East European airlines are considerably smaller in terms of passengers. The number of passengers vary from almost 5 million (LOT Polish) as a major airline in this group, to less than 1 million (Adria Airways) in 2012. As it can be observed, the number of aircraft is in a line with the number of passengers, ranging from around 600 in the case of LH Group to 14 aircraft owned by Adria Airways.

3. METHODOLOGY

3.1. Model specification

The DEA performance analysis applies the input-oriented Charnes-Cooper model [5]. The mathematical formulation of the model can be expressed as:

$$\max h_k = \frac{\sum_{r=1}^s u_r y_{rk}}{\sum_{i=1}^m v_i x_{ik}} \quad (1)$$

Subject to:

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad (2)$$

$$u_r \geq \varepsilon \text{ for } r = 1, 2, \dots, s \quad (3)$$

$$v_i \geq \varepsilon \text{ for } i = 1, 2, \dots, m \quad (4)$$

The non-negative values u_r and v_i (larger than small positive value ε - Eq. 3 and Eq. 4) are weights assigned to each of the output (y_{rk}) and to each input (x_{ik}), respectively. The objective in Eq. 1 is to maximize the relative efficiency score h_k , of one decision-making unit k (airline) defined as a ratio of the weighted sums of their outputs and the weighted sum of their inputs, subject to the efficiency of all units being ≤ 1 (Eq. 2).

Measurement of efficiency performance required detailed selection of input and output indicators. The model distinguishes four subcategories of airline inputs: capacity, resources, costs and marketability aspect of an airline service further divided as follows (Figure 3):

- The capacity is expressed through Available Seat Kilometre (ASK), the measure of an airline total flights' passenger carrying capacity, obtained by multiplying the number of seats available by the number of kilometres flown.
- The resources subcategory encompasses both human (number of employees) and material (fleet size expressed as number of aircraft) resources owned by an airline.
- The cost aspects include both employee cost (expressed as employee cost per ASK) and unit cost (total operating cost divided by ASK) incurred by airline's operation.
- Marketability aspects tend to reflect the level of service offered to passengers. It is described by the number of destinations that an airline serves through its network and on-time performance (i.e. punctuality) of its flight (the portion of all flights performed within the 15 minutes after scheduled time of arrival/departure).

Finally, the outputs encompass two set of indicators reflecting two main aspects of performance:

- The productivity aspect is expressed through several variables such labour productivity (passenger per employee), resources usage (aircraft per employee), transport productivity expressed as revenue passenger kilometre - RPK) and load factor (the portion of occupied seats on all flights);
- The economic aspect includes three most important financial indicators - operating revenue, net profit and net profit margins that reflect an airline's overall financial performance.

The DEA model measures the airline's efficiency scores by taking into account all above listed input variables in respect to three single outputs selected

(RPK, Passenger per employee and Operating revenue). Additionally, Fig. 4 depicts the efficiency scores

for all airlines from the set for all outputs indicated above classified according to their similarities.

Figure 3 – CCR-DEA model specification

3.2. Data

Extensive data development and processing has been necessary to construct the database used in this study. The primary data are compiled mainly from airlines' Annual Reports for 2008 and 2012 combined with separate financial reports published by some airlines (for example Norwegian, EasyJet, etc.). Substantial amount of data was obtained directly from airlines' website. The information about fleet was derived from several Internet sites, such as <http://www.airfleets.net>.

4. RESULTS

The DEA results are presented in Table 1. Overall, it can be observed that LCCs, Ryanair and EasyJet,

perform better than full-service airlines in both 2008 and 2012. Certainly, their better performance is due to the fact that they are able to get the most of their inputs, primarily the extensive usage of their labour sources and low unit cost compared to other airlines. Not surprisingly, Norwegian's efficiency scores are slightly lower than low-cost carriers.

Although, business model of this airline combines the characteristics of both low-cost and full-service carriers, it is evident that company successfully uses its resources and keeps its performance constantly efficient over observed period. Figure 3 proves this claim since the efficiency scores of these three airlines follow the similar pattern with Ryanair performing most efficiently in terms of all considered outputs.

Table 1. Airline efficiency CCR scores (h_k) for different set of airlines in 2008. and 2012.

Set of airlines	Airline	Revenue Passenger Km		Passenger per Employee		Operating Revenue	
		2008	2012	2008	2012	2008	2012
Mega European airlines (group)	Lufthansa group	1.00	0.95	0.07	0.11	1.00	1.00
	Air France-KLM	1.00	1.00	0.06	0.09	0.97	0.96
	IAG (British Airways/Iberia)	1.00/0.98	1.00	0.10/0.20	0.13	0.83/0.94	1.00
Low-cost airlines	Ryanair	1.00	1.00	1.00	1.00	1.00	1.00
	Easyjet	1.00	1.00	1.00	1.00	1.00	1.00
Full-service and hybrid airlines from West Europe (single)	SAS	0.85	0.82	0.18	0.27	0.94	0.95
	Finnair	0.90	0.89	0.19	0.31	0.86	0.96
	Air Berlin	0.94	0.90	0.42	0.52	1.00	1.00
	Norwegian	0.92	0.90	1.00	1.00	1.00	1.00
Airlines from Central and South-East Europe	Czech Airlines	0.78	0.78	0.22	0.64	0.77	1.00
	LOT Polish	0.85	0.87	0.28	0.91	0.80	1.00
	Adria Airways	0.68	0.74	1.00	1.00	1.00	0.92
	Croatia Airlines	0.76	0.76	1.00	0.88	0.84	0.76
	JAT Airways	0.74	0.81	0.43	0.52	0.50	0.52
Middle-East carrier	Tarom	0.72	0.73	0.31	0.38	0.57	0.58
	Emirates	1.00	1.00	0.14	0.12	1.00	1.00

As it can be seen from Table 1, three leading mega carriers in Europe (LH Group, AF-KLM and IAG) together with Emirates tend to be very efficient in terms of RPK and Operating revenue, while exhibit poor performance concerning productivity (passenger per employee). These three companies hire large number of employees in vast number of sectors which bring additional difficulties in labour optimization.

Classified as a medium efficient, the efficiency scores of airlines smaller in scope and size (such as SAS, Finnair, Air Berlin, LOT Polish and Czech Airlines) are lower than the scores of their previously mentioned counterparts, but still significantly higher than the scores of airlines located in South-East Europe.

As previously said, the bottom airlines in terms of efficiency are those from South-East Europe (Jat Airways, Tarom and to some extent Croatia Airlines), although they made slight improvements in 2012 compared to 2008. The severe political and economic crisis that took place in 90s in the countries of South-East Europe had tremendous impact on airline sector inducing a significant drop in the number of passengers and

put burden of financial losses that have been persistently recorded. Although located in SEE, Adria Airways was not that hardly hit by ethnic war and economic downturn, and thus efficiency performance remained higher compared to other SEE airlines. However, Adria's efficiency score in terms of operating revenue has worsen in 2012. compared to 2008, indicating serious problems mainly stem from newly arisen market conditions.

The finding that LOT Polish and Czech Airlines are becoming relatively more efficient over the two observed years is consistent with institutional and organizational developments that aims at reducing financial losses accumulated during substantial period of times. For example, in response to the global financial crisis, the Czech Airline's management board had successfully implemented the 2009 Action Plan involving a set of drastic downsizing and restructuring measures, which also includes personnel measures. In this way, both Central European company exhibit the improvements in efficiency, particularly in terms of operating revenue and productivity (passenger per employee) as direct effect of labour downsizing.

Figure 4 – Comparative analysis of airline efficiency

5. CONCLUSION

Although the global economic crisis was one of the most severe event that ever hit the airline industry, it seems that airline sector has recovered faster than anyone could expected. The results of a DEA analysis show that LCCs have performed better than the rest airlines from the set during the turbulent period. The second group of airlines in terms of efficiency are European mega carriers together with Emirates Airlines

that tend to exert inefficiency only in productivity aspects (passenger per employee). The middle efficient carriers are those representing national full-service carriers smaller compared to three mega airlines and their efficiency remained stable during observed years. Despite the fact that Central European carriers had found difficulties to overcome financial losses and persistent inability to adjust to a new emerged market conditions, the efficiency results has shown notable

enhancement in efficiency scores in 2012. Finally, the efficiency results for the carriers from South-East Europe, among which Jat Airways and Tarom are the least efficient in terms all considered outputs, indicate the prompt need for revision of their business model.

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SUMMARY

EFIKASNOST AVIOKOMPANIJA U TURBULENTNOM PERIODU PRE I POSLE SVETSKE EKONOMSKE KRIZE

Rad ima za cilj analizu performansi 17 aviokompanija koje saobraćaju širom Evrope u 2008. i 2012. godini. Tokom ovog perioda aviokompanije su se suočile sa ozbiljnim izazovima u svom poslovanju koji su nastali kao direktna posledica svetske ekonomske krize koja je započela 2008. godine. Pored vodećih evropskih aviokompanija, uzorak sadrži i nekoliko većih aviokompanija iz Centralne i Jugoslovene Evrope s obzirom na to da iste nisu bile predmet istraživanja velikog broja relevantnih naučnih radova. U radu je korišćen standardni DEA pristup sa ulazima koji se mogu podeliti u nekoliko grupa (resursi, troškovi, kapacitet itd.) i izlazima koji sadrže indekse koji opisuju ekonomsku stranu poslovanja posmatrane aviokompanije kao i njenu produktivnost. Rezultati modela ukazuju na neefikasnost aviokompanija iz Centralne i Jugoslovene Evrope u poređenju sa posmatranim aviokompanijama iz Zapadne Evrope. Sa druge strane, vodeće evropske niskotarifne aviokompanije su u svom poslovanju efikasnije od pomenutih zapadnoevropskih aviokompanija. Model takođe omogućava uvid u uzroke neefikasnosti što je posebno značajno kako bi aviokompanije mogle da poboljšaju svoju efikasnost u budućnosti. Uprkos ozbiljnoj ekonomskoj krizi, rezultati modela ukazuju da su se posmatrane aviokompanije oporavile znatno brže nego što bi to iko mogao da očekuje.

Ključne reči: efikasnost aviokompanija, DEA metoda, svetska ekonomska kriza