THE IMPACT OF THE LOW COST CARRIER PRESENCE ON THE DATA ENVELOPMENT ANALYSIS EFFICIENCY OF AIRPORTS

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Abstract: *The present paper aims to fill the apparent gap in existing literature and propose proper methods for determining an impact the presence of low cost carriers has on airport efficiency. The impact of the low cost carrier presence on the efficiency of chosen airports was calculated by simple linear regression. The number of low cost carriers operating from certain airports was considered and independent variable while the calculated data envelopment analysis efficiencies were considered as dependent variables. The results clearly indicate that there is a positive correlation between the number of low cost carriers and the airports efficiency.*

Keywords*: Airport efficiency, Data Envelopment Analysis, Low Cost Carriers*

1. INTRODUCTION

Low Cost Carriers (LCC) in Europe first appeared in the late nineties with the help of deregulations of airspace that were put in place through the European Union. They lowered the services provided to the customers and started selling the tickets over the internet. Despite all this the LCC trend managed to succeed and still sees rapid growth in the last decade (Francis, 2005). Modern LCCs enable the customer to travel cheaply with low fares to an ever increasing number of destinations. The growth can be best seen in numbers of short haul passengers carried in Europe. In 2003 LCCs were responsible for 10% of short haul passenger traffic in Europe (Francis, 2003). By year 2013 this share has increased to 26% according to traffic analysis made by Eurocontrol (EPRS, 2014). This number falls short of the predictions that LCCs would control 33% of the market share by year 2010 but they are none the less showing the trend towards the growth of LCC passenger traffic.

While there were numerous studies conducted on LCC impacts towards competition, fare prices and traffic numbers as claimed by Graham (2013), the subject of LCC effects on airport efficiency and airport performance remain few and far between. Most of existing work material is further limited to major European tourist areas and bigger well known airports.

Aim of this research paper is to fill the apparent gap in existing literature and propose proper methods for determining an impact the presence of LCCs has on airport efficiency in the Adriatic region. The airports we have chosen for this sample study are considered small but the region itself is very dependent on their existence. One of the reasons for the dependence is the fact that the region set its future goals in developing tourism, therefore efficiency and development of said airports is one of the key factors in success of the region in the future.

2. LITERATURE REVIEW

Air traveler satisfaction has been noted to constantly drop in the past decade. In order to combat this problem a constant effort has been made in measuring and comparison of airport performances of competing airports while at the same time another trend of Airport congestion growing has been noted. Operational efficiency of airports is therefore becoming one of the important determinants of the system's success in the future (Schaar & Sherry, 2008).

Pyrialakou and coauthors proposed to assess the operational efficiency of airports where high levels of low-cost carrier traffic can be seen using a nonparametric method called Data Envelopment Analysis (DEA) (Pyrialakou, Karlaftis, & Michaelides, 2012). Using this method two models have been developed. The first model is used in order to assess the terminal services and the other is used in order to assess the airside operations. Data inputs for both methods consist of the number of gateways used, number of runways used and the number of aircraft movements on the airport, while number of enplaned passengers was used as data for output part of the model. The results of this model show high correlation between enplanements, terminal efficiencies and hours of operation of chosen airports. Impacts of LCC services on efficiency of major U.S: airports have been addressed in the study done by Choo and Oum (2013). The study was conducted using the Index Number Approach as the primary method for determining the efficiency of chosen airports but in addition, the SFA approach was used to ensure the robustness of obtained results. In contrast of the previously mentioned study the research determined, that the LCC presence on major U.S. airports has shown a negative effect on operating efficiency of the chosen airports.

Schaar and Sherry have exposed the differences in results using various different DEA methods (Cooper-Charnes-Rhodes (CCR), Banker-Charnes-Cooper (BCC), and Slacks-Based Measure of efficiency (SBM)) (Schaar & Sherry, 2008). Results were obtained using the data from 45 airports in the time frame between 1996 and 2000. Further analysis has shown a wide variation in results, which prompted the discussion of the need for guidelines for selection of proper DEA models and proper interpretation of DEA results in the paper. Research conducted by Yoshida and Fujimoto focused on testing the criticism of overinvestment in Japanese regional airports (Yoshida & Fujimoto, 2004). Researchers employed two distinctly different methods, Data Envelopment Analysis and endogenous-weight Total Factor Productivity method (TFP). Results of both methods indicated that the regional airport efficiency of Japan airports is not as high as the others. At the same time the research exposed an interesting fact that the airports constructed in the 1990s were relatively inefficient compared to airports built in different points in time.

3. METHODOLOGY

In previous section we established the most commonly used methods for measuring airport efficiency and productivity. Methods in question are Index Number Method, Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). First method (INM) is used for direct measurement of productivity as output index over the input index. The productivity factor of airport can be determined as the ratio of aggregate output and input indexes. The second method in question is DEA. Its deterministic approach is based on the assumption that all observed deviations are the result of inefficiencies. The last method noted is SFA. The method is using a stochastic approach to modelling which enables the model to account for both deviations caused by inefficiencies and deviations caused by measurements errors, random errors and statistical discrepancies.

The method chosen for the efficiency calculations in this paper is the DEA method. One of the main advantages of the chosen method is the fact that it does not require more data than input and output quantities. The efficiency is calculated relative to the highest observed performance

and not the average observed performance (Kamil, Baten, & Mustafa, 2012). According to Schaar & Sherry (2008) the choice of the appropriate DEA model is key for the study. We have decided on the usage of the output oriented Constant Return of Scale model which is not usually suitable for usage in cases where the Decision Making Unit (DMU) does not reach optimum operation. We support this decision due to the fact that the usage of competing Variable Return of Scale model the largest and the smallest airport in the sample would become vastly overstated in terms of efficiency. We calculated the impact of the LCC presence on the efficiency of chosen airports using the method of simple linear regression. The number of LCCs operating from certain airports was considered and independent variable while the calculated DEA efficiencies were considered as dependent variables.

4. DATA

The data sample for this paper was chosen from the airports operating in the Adriatic Sea region. Not all airports are located in the coastal region but all of them are commercially connected the coast. For purposes of this research paper five of the airports were chosen. The selection can be seen on the Figure 1.

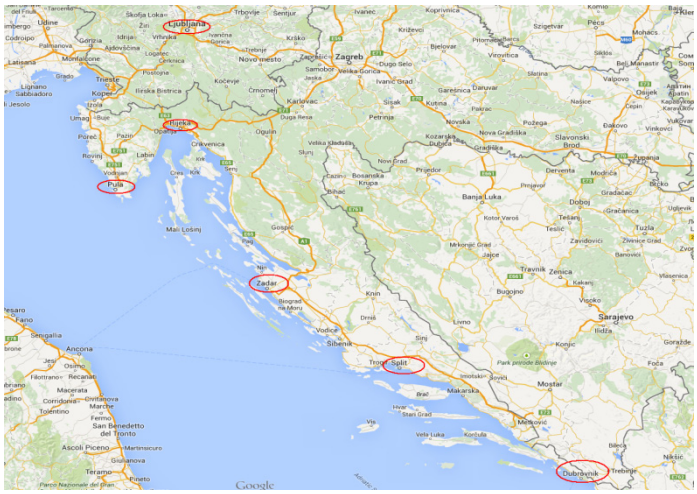

Figure 1: Selected airports in Adriatic region

Criteria for airport selection demand that the selected airport must provide scheduled flights with at least one airline and process at the very least 15000 passengers in a year. We limited the data selection in the time frame between year 2006 and year 2013. Our primary sources of data consist of Air Traffic Reports provided by ACI (2014). Other sources of data are Airport-data.com (2014) web page and data collected directly from the airport authorities. Using the procured data we built three distinct Output Oriented DEA models based on CRS algorithm. The model considers the extent in which outputs could be increased while using the same inputs, relatively to the standards set by the competing units. The inputs and outputs used are presented in the Table 1.

Table 1: Inputs and outputs

Inputs	Outputs
Flight Efficiency Model (output oriented CRS)	
Number of runways	Aircraft movements
Length of the longest runway	
Number of destinations	
Passenger Efficiency Model (output oriented CRS)	
Number of operating carriers	Passenger throughput
Car park capacity	

Table 1: Inputs and outputs (continued)

Distance to city center	
Number of passenger terminals	
Number of gates	
Overall Efficiency Model (output oriented CRS)	
Number of operating carriers	Passenger throughput
Car park capacity	Aircraft movements
Distance to city center	
Number of passenger terminals	
Number of gates	
Number of runways	
Length of the longest runway	
Number of destinations	

The same type of analysis could also be used to analyze the efficiency of airports while handling cargo as we can see from the already established analysis measuring the technical efficiency of airports in Latin America. The study used similar data set compared to our research paper with the added freight movements as an output category as well (Perleman and Serebrisky, 2012). Due to the fact that Low Cost Carriers focus is moving passengers we decided to eliminate this output variable from our study. Air companies considered as LCC and involved in our study are the following: Air Berlin, Air One, Blue air, Blue express, Blue Panorama airlines, EasyJet, Flybe, Germanwings, HOP!, Intersky, jet2.com, Monarch airlines, Norweigian airline, Pegasus airline, Ryanair, Smart wings, Transavia airline, Volotea, Vueling, Wizz Air, Sky Europe, Eurolot and Edelweiss. The number of airlines at distinct airports over the years is presented in the Table 2.

Table 2: The number of LCC at distinct airports.

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Ljubljana	2	2	2	2	1	2	2	2
Pula	1	2	3	3	3	3	4	4
Zadar	0	2	2	2	2	2	2	2
Split	2	2	3	4	5	5	9	9
Dubrovnik	1	3	4	7	8	8	9	9

5. RESULTS

The DEA efficiency numbers were obtained with the help of LIMDEP 10 software using the FRONTIER function with ALG=DEA and CRS limiters.

5.1 DEA Efficiency

In the Table 3. we can see the calculated Flight Efficiencies for selected airports over eight years, from 2006 to 2013.

Table 3: Flight Efficiency

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Ljubljana	1	1	1	1	1	1	1	1
Pula	0,26398	0,266678	0,287911	0,294223	0,23532	0,26086	0,298703	0,32706
Zadar	0,077127	0,078691	0,085384	0,094276	0,103199	0,114264	0,149574	0,163177
Split	0,546255	0,482707	0,468695	0,488964	0,533392	0,57406	0,643143	0,693237
Dubrovnik	0,362408	0,323483	0,309278	0,315274	0,365042	0,408753	0,463077	0,492216

We can see that Slovenian airport is relatively much more Flight Efficient than Croatian ones.

The calculated Passenger Efficiency is shown in the Table 4.

Table 4: Passenger Efficiency

	2006	2007	2008	2009	2010	2011	2012	2013
Ljubljana	1	1	1	1	1	1	1	1
Pula	0,68734	0,872912	0,860893	0,74044	0,682456	0,69237	0,664775	0,617474
Zadar	0,168036	0,267714	0,343728	0,529231	0,657782	0,664192	0,875956	1
Split	1	1	1	1	1	1	1	1
Dubrovnik	1	1	1	1	1	1	1	1

Here, efficiency is not geographically dependent, but yet, some airports are still much more effective than the others.

The Overall Efficiency is calculated with respect to two outputs (passenger throughput and aircraft movements). The results are presented in the Table 6.

Table 6: Overall Efficiency

	2006	2007	2008	2009	2010	2011	2012	2013
Ljubljana	1	1	1	1	1	1	1	1
Pula	1	1	1	1	1	1	1	1
Zadar	0,259897	0,275256	0,343728	0,529231	0,657782	0,664192	0,875956	1
Split	1	1	1	1	1	1	1	1
Dubrovnik	1	1	1	1	1	1	1	1

5.2 The impact of LCC presence on Efficiency

The impact of LCC presence on efficiency of airports is estimated by simple linear regression using LIMDEP. The number of LCC flights from certain airports over the years was considered as an independent variable while the calculated defined DEA efficiencies were considered as the dependent variable. The correlation coefficients, explaining the impact of LCCs, are listed in Table 7.

Table 7: Calculated correlation coefficients

	Flight Efficiency Coefficient	Passenger Efficiency Coefficient	Overall Efficiency Coefficient
Ljubljana	0	0	0
Pula	0,56186	-0,37052	0
Zadar	0,3877	0,54531	0,46351
Split	0,88393	0	0
Dubrovnik	0,6454	0	0

The results shown in the last table clearly indicate that there is a positive correlation between the number of low cost carriers and the airports efficiency. The negative number in Pula segment was caused by a rapid decline of number of the passengers due to economic crisis. In instances where optimal efficiency has been calculated thorough the whole time of observation the correlation shown is 0 due to the way the correlation coefficient is calculated. Further research featuring more airports and more data is required to further explain the correlation between LCCs and airport efficiency. After further analyzing, the impact the LCC could have on freight cargo we discovered that most LCCs based in Europe do not think pursuing the freight market is a good idea and they tend to stay on the familiar territory of passenger transport. Airlines such as Norwegian claim that they will not compete with established carriers in prices despite trying to succeed in freight transport as well (Lennane, 2013). As such, we can conclude that current day LCCs do not pose a significant factor in changing the efficiency with the inclusion of freight flows. This however might change in the future as more aggressive tactics could be used by the LCCs.

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