

# Evaluation of Effectiveness of Regional Airports in Central Europe by Data Envelope Analysis

Ivana Stryčeková<sup>1</sup>, Anna Tomová<sup>2</sup>

<sup>1</sup>Ministry of Defence of the Slovak Republic, 800 00 Bratislava,

<sup>2</sup>Department of Air Transport University of Žilina, 010 26 Žilina, Slovak Republic

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**Abstract:** In the paper we evaluate economic efficiency of 20 regional airports in Central Europe (Bratislava capital airport including) within 2004 – 2010 using input oriented data envelope analysis (DEA) with constant return on scale to identify super efficiency score. The paper results contribute to airport economic benchmarking literature which is still insufficient just for airports of regional nature. Covering 12 economic inputs and outputs parameters our research revealed Bratislava airport as efficient all the period within the sample analyzed which may be subsequently used as a supportive argument when stating development strategy for Bratislava airport.

**Keywords:** effectiveness, regional airport, Central Europe, DEA, benchmarking

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## 1. Introduction

The production of air transportation services is characterized by two vertically separated levels. “Up stream” level of the market is ensured by infrastructure aviation entities, airports included which provide necessary aeronautical infrastructure and infrastructure services for air carriers. Airports as economic entities are unique systems not only with regard to technology used but also taking into account specific exogenous and endogenous economic drivers of airports business in the corresponding airport markets. Traditional comprehension of airports in managerial practice and in economic research as well is in the state of flux reflecting changes in ownership and governance of airports in the world. Many airports which were historically only administrative ministerial arms without any autonomous competencies are nowadays modern business entities of decentralized, commercialized, corporatized and/or privatized companies<sup>1</sup> running their activities on partially or fully commercial basis. It has created natural pressure on research of airports economic effectiveness in theory and practice as well.

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<sup>1</sup> The first wave of airports privatization started by BAA privatization in Great Britain (London Heathrow, London Stansted, London Gatwick) by IPO method at the eighties. The process continued by privatization of regional airports in Great Britain (Cardiff, East Midlands, Belfast etc.) spilling to other parts of the world. In Europe, IPO method was used for airports privatization in Vienna, Copenhagen, Rome, Zurich etc. Direct sales were applied in airports privatization in Liege, Brussels, and Dusseldorf etc. Approaches to airports privatization are discussed more in Cruz – Marques [15]. Airport Council International estimates that partially or fully privatized airports cover about 48 % of passengers handled by European airports. [2].

Economic research of airports effectiveness used originally a system of partial indicators in four areas – labour and capital productivity, profitability, costs intensity and revenue generation.<sup>2</sup> Any of the indicators used expressed different dimensions of airport effectiveness which was without any doubt very useful for everyday managerial decisions. However, this approach did not enable to assess airports effectiveness by one complex parameter.<sup>3</sup> In 1997, Gillen and Lall published the first study aimed at airports effectiveness by Data Envelope Analysis (DEA) to reveal effectiveness of 21 airports in the USA covering period 1989 – 1993. [7] The study encouraged an emergence of similar studies focusing on measurement of economic effectiveness of airports by multidimensional methods – DEA, stochastic production function (SPF) and total factor productivity (TFP). The research swing to multidimensional methods was clearly formulated by Humpreys et al. in 2002: “Highly quantitative methodologies such as data envelope analysis (DEA) and total factor productivity (TFP) have been applied to airports in order to measure inputs in relation to outputs. [17] In Table 1 we introduce overview of airports effectiveness research milestones according to the method used covering papers published between 1997 – 2010 and in Table 2 we characterize the papers according to number of airports and time period analyzed. As we can see

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<sup>2</sup> Revenues of airports are generated by aeronautical activities and services and non-aeronautical activities and services. In 2001 non aeronautical revenues represented 15 % of the total revenue of world airports presently they account about 46 % of the total revenues of world airports. [7].

<sup>3</sup> Partial indicators are still used in practice and they are still very important in economic benchmarking of airports provided by the world air research laboratories - ATRS, GARS, TRL.

in the tables the measurement of effectiveness started to be accompanied by effort to test drivers of effectiveness such as ownership structure, regional economic growth, size of airports catchment area, local airports competition. It is natural that the research has been concentrating on large airports which catch a significant proportion of world demand for air transportation services.

**Table 1.** Overview of airports effectiveness research milestones

Author(s)	Airports Number, Airports Localization	Period Analyzed
Gillen/Lall (1997)	21 USA	1989-1993
Hooper/Hensher (1997)	6 Australia	1989-1991
Graham/Holvad (1997)	25 Europe 12 Australia	1993
Vasigh/Hamzaee (1998)	7 USA	1990-1993
Parker (1999)	32 Great Britain	1988/89-1996/9
Murillo-Melchor (1999)	33 Spain	1992-1994
Jessop (1999)	32 world	1997-2002
Nyshadham/Rao (2000)	25 Europe	1995-1997
Sarkis (2000)	44 USA	1990-1994
Pels/Nijkamp/Rietveld (2001)	34 Europe	1995-1997
Gillen/Lall (2001)	22 USA	1989-1993
Martin/Roman (2001)	37 Spain	1997
Abbott/Wu (2002)	12 Australia	1990-2000
Martin-Cejas (2002)	40 Spain	1997
Pacheco/Fernandes (2003)	35 Brazil	1998
Bazargan/Vasigh (2003)	45 USA	1996-2000
Holvad/Graham (2003)	21 Great Britain	1993-1997
Pels/Nijkamp/Rietveld (2003)	33 Europe	1995-1997
Sarkis/Talluri (2004)	44 USA	1990-1994
Barros/Sampaio (2004)	13 Portugal	1990-2000
Yoshida (2004)	30 Japan	2000
Yoshida/Fujimoto (2004)	43 Japan	2000
Kamp/Niemeier/Mueller (2005)	17 Europe	1998-2003
Vogel (2006)	35 Europe	1990-2000
Lin/Hong (2006)	20 world	2003
Vasigh/Gorjidoz (2006)	22 Europe, USA	1900-1999
Oum/Adler/Yu (2006)	116 world	2001-2003
Barros/Dieke (2007)	31 Italy	2001-2003
Oum/Yan/Yu (2008)	109 world	2001-2004
Fung/Wan/Hui/Law (2008)	25 China	1995-2004
Barros (2008)	27 Great Britain	2000-2005
Barros/Assaf/Lipovich (2008)	31 Argentina	2003-2007
Tseng/Ho/Liu (2008)	20 world	2001-2005
Mueller/Ulku/Živanovic (2008)	7 Great Britain a 6 Germany	1998-2005
Curi/Gitto/Mancuso (2009)	36 Italy	2001-2003
Barros/Weber (2009)	27 Great Britain	2000-2005
Suzuki/Nijkamp/Pels/Rietveld (2009)	19 Europe	2003
Martin/Roman/Voltes-Dorta (2009)	37 Spain	1991-1997
Assaf (2010)	27 Great Britain	1998-2008

Only one paper of Fung et al. within the list covered by this paper investigated regional airports. The papers introduced are different also with regard to inputs and outputs included in analyses, mainly in inputs parameters where a higher diversity is recorded (number and capacity of runways, stands numbers, numbers of check-in decks, assets value,

number of employees, costs values totally or according to costs categories etc.)<sup>4</sup> As for methodology used, DEA was the most frequent within the studies. Applied independently or in combination with SFA or TFP methods, DEA was used in 29 of the studies mentioned. None study focused on airports explicitly in Central Europe nor yet European regional airports.

## 2. Methodology

In our research we focused on efficiency of regional airports in Central Europe. The term regional airport per se requires deeper explanation as it is strongly influenced by analytical context. In the European Union there is none unambiguous definition of regional airport. According to the opinion expressed in the EU document The capacity of regional airports (CdR 393/2002) adopted on 2 July 2003, regional airport is any airport with passengers handled between 200 000 and 5 million per year. The document states that under some circumstances also airports with passengers handled over five million up to ten million per year can be considered as regional ones. In the Communication from the Commission named Community Guidelines on Financing of airports and start-up airlines departing from regional airports (2005/C 312/01) regional airports for the purposes of the guidelines are split into two categories – small regional airports with passengers fewer than one million per year and big regional airports with passengers handled from one to five million per year. The Decision No 661/2010/EU of the European Parliament and of the Council of 7 July 2010 on Union guidelines for the development of the trans-European transport network define airports of common interest composed of international connecting points, Union connecting points and regional connecting and accessibility points. The airports serving functions of regional connecting and accessibility points include all airports with an annual traffic volume of between 500 000 and 899 999 passenger movements, of which less than 30 % are non-national, or with an annual traffic volume of between 250 000 minus 10 % and 499 999 passenger movements, or with an annual traffic volume of between 10 000 and 49 999 tons freight throughput, or located on an island of a Member State, or located in a landlocked area of the Union with commercial services operated by aircraft with a maximum take-off weight in excess of 10 tons. The regional connecting or accessibility points must be situated out of the area with radius of 100 km from the nearest international connecting point or Union connecting point. Within this airport categorization only those airports important for development of transeuropean transport network are taken into account, therefore such definition will not cover all regional airports narrowing in this scope the EU regional airports. Therefore, we included in our analysis twenty airports in Central Europe from four Member States – the Slovak Republic, the Czech Republic, Poland and Aus-

<sup>4</sup> We fully agree in this with Klieštík who stated: “in case of transport companies a decision about parameters expressing inputs and outputs is not simple and unambiguous...” [31]

tria in time period of seven years.<sup>5</sup> Regional nature of the airports chosen is given mainly by performance indicator expressed through number of passenger handled per year. No of the airports analyzed did not exceed 3 million value annually which corresponds with regional airport definition stated by the EU document about the capacity of regional airport. Three of the airports are in line with micro-airports category with performance lower than 200 000 passengers handled per year. According to the Communication from the Commission named Community Guidelines on Financing of airports and start-up airlines departing from regional airports we worked in our analysis with categories of small regional airports (Poprad-Tatry, Žilina, Pardubice, Brno, Košice, Ostrava, Graz, Klagenfurt, Linz, Bydgoszcz, Lodz and Szczecin) and large regional airports as well (the rest of airports). Taking into account importance of the airports analyzed for development of transeuropean network there are airports serving as connecting points in the EU (Bratislava), airports serving as regional connecting point (Brno) and airports out of the transeuropean network importance (Poprad-Tatry). Besides performance characteristics we considered also typical qualitative distinctions of regional airports such as serving airlines operating point-to-point network mainly low cost carriers, high level of seasonality, significant portion of charter operation at airport, marginal importance of cargo transportation). All analyzed airports are moreover situated at destinations which are attractive as tourist centers or business centers. For our analysis we gathered twelve inputs and outputs indicators, eight of input nature (number and size of runways, number of stands, number of gates, number of check-in desk for passengers, number of baggage belts, number of aircraft parkings, number of employees, operational time, operational costs, labor costs, assets value) and four of output nature (passengers handled, cargo handled in tons, aircraft movements and total revenues). We used the input oriented DEA method with constant return on scale to reveal Super Efficiency of twenty regional airports included in analysis within 2004 – 2010.<sup>6</sup>

## 4. Results

In Table 2 we gathered the results of efficiency analysis applied to twenty regional airports in Central Europe. The results revealed that only Szczecin airport as the only one from the list had been ineffective all the period analyzed. On the other hand, airports Bratislava, Žilina, Brno, Innsbruck, Klagenfurt, Linz, Salzburg, Gdansk, Katowice and Krakow were effective all the period analyzed. The analysis identified airports Poprad-Tatry, Pardubice, Poznan and Wroclaw as frequently ineffective.

Overlapping the results by domicile characteristics of airports we concluded that all Austrian regional airports had been effective excepting for the result from Graz airport in 2008. Airports Ostrava, Pardubice and Poznan recorded shift of super efficiency scores from efficiency to inefficiency levels within the period analyzed. Going through ownership characteristics of airports identified as effective by DEA method we find within effective airports different governance models: Bratislava airport in central government ownership, Graz airport in decentralized public ownership, Brno airport in public ownership, however operated by a private company or airports in central public (government) ownership operated by entity composed of different public owners according to country administration levels (Gdansk, Katowice), Klagenfurt is in a mixed public-private partnership. Although being static, our analysis revealed size of catchment area and demands fluctuation as determinants of efficiency result.

## 4. Conclusions

As airports are unique operational and economic entities any assessment of their economic performance is undermined by many influencing factors. Time scope of analysis, compass of airports evaluated, methodology used, data availability – are the most relevant among them. In our analysis we used input oriented DEA super-efficiency approach to identify and compare efficiency of twenty regional airports in Central Europe within eight consecutive years encompassing the EU biggest enlargement year 2004, as well as years of economic crises 2009 and 2010. Bratislava airport efficiency score seem to be satisfactory within the sample analyzed. However, just enlistment of Bratislava airport among airports analyzed may be considered as the most controversial in our methodology as it is the only capital airport within the sample investigated. On the other hand, Bratislava airport is according to its performance fully comparable with airports in Innsbruck and Salzburg and three Polish airports analyzed Krakow, Katowice and Gdansk are almost bigger ones. Uniqueness of Bratislava airport consists in shared catchment area with another European Union capital airport in Vienna – a factor that is really very specific compared with other airports in our research. Albeit, taking into consideration qualitative feature of Bratislava airport, it corresponds to characteristics of regional airports in prevailing aspects of its operation. Therefore, to achieve complex evaluation of Bratislava airport efficiency, the satisfactory DEA efficiency scores of Bratislava we identified ought to be confronted within the sample of European capital airports, i.e. going out of the regional airports scope will be necessary in further research to dispose of arguments pros or cons against still vivid ideas of Bratislava airport privatization.

<sup>5</sup> Our original intention to work also with regional airports in Hungary failed due to data insufficiency.

<sup>6</sup> We used also output oriented DEA method considering not only constant return on scale but also variable return on scale. As the results are conforming with those we mention in the text of the paper for input oriented DEA with constant return on scale.

**Table 2.** Super Efficiency Score of Regional Airports in Central Europe by DEA method 2004-2010

	Year							Average 04-10	Rank based on average score 04-10	Rank 2010
	04	05	06	07	08	09	10			
Bratislava	2.686	3.512	1.961	1.688	2.021	2.456	1.917	2.320	5.	6.
Košice	1.540	<b>0.864</b>	<b>0.889</b>	1.276	1.207	1.074	1.049	1.128	12.	13.
Poprad/Tatry	<b>0.724</b>	<b>0.873</b>	<b>0.959</b>	1.084	<b>0.790</b>	<b>0.800</b>	1.010	0.891	19.	14.
Žilina	5.692	10.714	5.194	4.516	4.144	4.555	6.000	5.830	2.	2.
Brno	2.404	2.196	2.698	2.767	3.198	4.433	2.711	2.915	3.	3.
Ostrava	1.463	1.414	1.029	<b>0.878</b>	<b>0.757</b>	<b>0.814</b>	<b>0.856</b>	1.030	16.	18.
Pardubice	2.050	2.010	3.279	2.445	1.578	<b>0.801</b>	<b>0.930</b>	1.870	9.	17.
Graz	1.260	1.158	1.117	1.008	<b>0.939</b>	1.060	1.008	1.079	14.	15.
Innsbruck	1.604	1.434	1.340	1.328	1.440	1.488	1.415	1.430	11.	9.
Klagenfurt	2.598	2.519	2.259	2.304	2.098	2.250	2.451	2.068	6.	5.
Linz	8.460	8.190	8.424	7.350	1.131	4.343	7.388	6.469	1.	1.
Salzburg	2.074	2.226	2.080	1.927	1.675	1.589	1.594	1.889	8.	8.
Bydgoszcz	<b>0.549</b>	<b>0.699</b>	<b>0.828</b>	<b>0.737</b>	1.047	1.286	1.129	0.896	18.	11.
Gdansk	1.104	1.117	1.529	1.605	1.734	1.927	1.666	1.526	10.	7.
Katowice	1.525	1.611	1.483	1.542	4.626	1.270	1.322	1.911	7.	10.
Krakow	2.054	2.306	2.626	2.668	2.972	2.919	2.685	2.604	4.	4.
Lodz	<b>0.814</b>	<b>0.892</b>	1.116	1.278	1.268	1.014	1.082	1.066	15.	12.
Poznan	1.249	<b>0.921</b>	1.175	<b>0.678</b>	<b>0.724</b>	<b>0.771</b>	<b>0.776</b>	0.899	17.	20.
Szczecin	<b>0.615</b>	<b>0.596</b>	<b>0.564</b>	<b>0.711</b>	<b>0.785</b>	<b>0.876</b>	<b>0.854</b>	0.714	20.	19.
Wroclaw	<b>0.872</b>	<b>0.915</b>	1.124	1.078	1.188	<b>0.947</b>	1.006	1.119	13.	16.

Source: Own Computation based on annual reports data.

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