Journal of Air Transport Management 40 (2014) 34–41

Contents lists available at ScienceDirect

Journal of Air Transport Management

journal homepage: www.elsevier.com/locate/jairtraman

Small is beautiful? The impact of economic crisis, low cost carriers, and size on efficiency in Spanish airports (2009–2011)

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ARTICLE INFO

Article history:
Available online 14 June 2014

Keywords:
Airports
DEA
Efficiency
Malmquist
Technological change

ABSTRACT

This paper carries out a comparative technical efficiency analysis of 35 Spanish airports using panel data for 2009–2011 with a data envelopment analysis (DEA) methodology. The results suggest that airport size has a positive impact on the technical and scale efficiency and that the presence of low cost carriers has positively affected the scale efficiency of the airports where they operate. The results also show that during the present economic crisis Spanish airports have experienced a dramatic productivity regress which is due to the reduction of their technological change component.

1. Introduction

During the last decade, two events have had major effects on the European airport industry and have generated a renewed interest in the way that the Spanish airport system is managed. These are the boom in low cost carriers (LCCs) following the liberalization of air transport and the recession that has affected the Spanish economy with particular virulence.

The participation of LCCs in air traffic in Spain has grown significantly in recent years. Spain is the second largest LCC market in Europe and LCCs dominate the Spanish scheduled air transport market. Specifically in the period 2009–2011, LCCs transported around 60% of passengers by air in Spain. LCCs generally use small and medium airports with lower airport charges, providing them with thriving business and bringing economic opportunities to their hinterlands (Tapiador et al., 2008). The rapid growth in the number of passengers in some small and medium airports due to the increased presence of LCCs might suggest that small airports are more efficient than large ones, in line with the title of the essay "Small is beautiful" by the British economist Schumacker (1973). Hence one key objective of this research is to provide an empirically proven answer to that question. Within the current literature concerning airports in different countries, some sources conclude that an airport's size is an irrelevant factor, some maintain that larger size offers higher efficiency and yet others conclude that larger airports are less efficient.

Hence overall the aim of this work is to analyse the efficiency and productivity of Spanish airports and their development over the period of the economic crisis, as well as to estimate the impact of size and the presence of LCCs on each airport's efficiency. The first contribution of this work is to verify, in line with the major part of the Spanish literature on airports, that larger airports are more efficient than smaller ones. This will be assessed for the period of economic crisis in Spain (2009–2011) when the presence of LCCs increased. So another contribution is to estimate the impact of LCCs on the efficiency of Spanish airports. To the best of our knowledge, Bottasso et al. (2012) and Choo and Oum (2013) are the only studies which have directly addressed the issue of LCC effects on airport efficiency and this paper will be the first to investigate these for the Spanish case.

In this research we use a two-step procedure (Pastor, 2002) to examine how external factors affect the level of observed efficiency. Scores of overall technical, pure technical and scale efficiency for 35 Spanish airports for 2009–2011 are regressed on a set of explanatory variables such as size and the share of LCC passengers. Also the changes in productivity during the economic crisis are analysed. The methodological tool used is data envelopment analysis (DEA), the non-parametric linear programming technique appropriate for

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http://dx.doi.org/10.1016/j.jairtraman.2014.05.006
0969-6997/

estimating the efficiency and returns to scale by means of constructing the most efficient frontier. This methodology has, among other things, an advantage in its flexibility, by not imposing any functional forms on the technological frontier. This approach allows the estimation of Malmquist indices of total factor productivity (TFP) change and its subsequent breaking down into indicators of technical efficiency change and technological change.

The structure of this paper is as follows. A review of relevant literature is performed in section 2. In section 3 the methodology is described and a brief summary of the variables and sources of data used in this study is provided. Results relating to efficiency, estimates of the regression model, and the temporal variation of the productivity of Spanish airports and their relationships with the specific characteristics of the airports are presented and discussed in section 4. Finally, in section 5 the main conclusions are presented.

2. Literature review

The literature review focuses primarily on the topic of airport efficiency and size. Other issues considered are the relationships between LCCs and efficiency of airports where they operate, and the impact of the economic crisis on the performance of airports. Pioneering research on airport efficiency was undertaken by Hooper and Hensher (1997) and Gillen and Lall (1997). Hooper and Hensher (1997) discussed the total factor productivity index of Australian airports for the period 1988–1992 using the method of index numbers and noted more technical efficiency for airports with most passengers. Gillen and Lall (1997) used DEA to study the efficiency in 21 US airports for the period 1989–1993 and concluded that larger airports were more efficient than smaller ones.

Abbott and Wu (2002) investigated the efficiency and productivity of Australian airports during the 1990s. They found no relationship between efficiency and size of the airports and pointed out that efficiency in the 1990s increased as a result of a displacement of the production function, rather than an increase in the size of airports. Pels et al. (2003) analysed the technical efficiency of European airports with DEA and stochastic frontier methods and in both cases verified that larger airports were more efficient than smaller ones. Bazargan and Vasigh (2003) analysed the efficiency of commercial airports in the US and concluded that larger airports were less efficient. Barros and Dieke (2008) analysed Italian airports with a single DEA frontier using a data panel for the period 2001–2003 and concluded that smaller airports were less efficient than hub airports.

Barros (2008a) studied the economic efficiency of UK airports for the period 2000–2005 using stochastic frontiers and concluded that, given the heterogeneity of UK airports, medium-sized airports were more efficient than large airports. By contrast, Perelman and Serebrisky (2010), using DEA, concluded that in the case of Latin America larger airports showed higher technical efficiency than smaller ones. Martın and Voltes-Dorta (2011) studied both technical and allocative inefficiencies of 161 airports worldwide using a stochastic frontier method. They found a positive impact of aircraft size on technical efficiency and also that airport technology exhibited unexhausted increasing returns to scale.

Specifically in Spain Murillo-Melchor (1999), Salazar (1999), Martin and Roman (2001) and Coto-Millán et al. (2007) analysed technical and economic efficiency of Spanish airports for the period 1992–1994. Furthermore, Tapiador et al. (2008) and Lozano and Gutierrez (2011) analysed efficiency for 2006 and 2007. The results of all empirical research for Spanish airports prior to the economic crisis coincided in indicating that larger airports, in terms of number of passengers, were more efficient. Tovar and Rendeiro Martín-Cejas (2010) analysed 26 Spanish airports between 1993 and 1999 with a stochastic distance function and concluded that hub airports showed an above-average level of efficiency and any efficiency change associated with airport size was negligible.

There is a very limited amount of literature on the effects of LCCs on airport operations and performance. Bottasso et al. (2012) found that the share of LCC passengers handled by an airport had a positive effect on total factor productivity of UK airports. On the contrary, Choo and Oum (2013) found that the intensity of the LCC presence impacted negatively on the operating efficiency of the major US airports.

Regarding the effects of the economic crisis, Barros (2008b) studied the impact of an economic crisis on technical efficiency of Argentina's airports from 2003 to 2007. He found that while major airports were largely immune to the economic crisis, small regional airports emerged as more sensitive. Furthermore, overall efficiency grew during this period. Voltes-Dorta and Pagliari (2012) studied the impact of the recession on the cost efficiency and financial performance of 194 airports worldwide over the 2007–2009 recession period and estimated the industry's short-run cost frontier. They concluded that there were very significant economies of capacity utilisation and a global drop of 5.85% in cost efficiency between 2007 and 2009. Table 1 presents a summary of this literature review.

3. Methodology and data used

3.1. DEA methodology

DEA, as described by Charnes et al. (1978), allows the relaxation of assumptions, such as that of constant returns, and the contemplation of more general cases, like that of multiproduct technology. By means of this technique, a frontier production of reference is built, using mathematical programming methods, on the basis of efficient productive units and linear combinations thereof (see Coelli, 1998). The measurements of efficiency are the distances that separate each company from the frontier. This DEA methodology is also used to determine the type of returns to scale. It consists basically of identifying the non-parametric linear polygonal frontier that would represent the optimum process in the transformation of a set of inputs into the final output. A description of the DEA methodology was carried out in Salazar (1999) and Cooper et al. (2000) and there are numerous studies in the literature on DEA methodology which identify economies of scale. This type of non-parametric frontier has been used profusely in the empirical literature, fundamentally in the banking, railways, airlines and airports sectors.

The exercise of linear programming which underlies the input-orientated DEA models with constant and variable returns to scale is presented below and is the one used in this research. For the jth airport out of n airports, the input-based technical efficiency (TE) under constant returns to scale (CRS) is obtained by solving the following linear programming (Coelli, 1996):

$$\mathrm{TE}_j = \underset{\theta_j^{\mathrm{CRS}},\lambda}{\mathrm{Min}}\ \theta_j^{\mathrm{CRS}} \text{ subject to : } Y_j \le Y\lambda; \quad \theta_j^{\mathrm{CRS}} X_j \ge X\lambda;\ \lambda \ge 0 \qquad (1)$$

where X and Y are the input and output vectors, respectively, θ_j^{CVS} is the technical efficiency of airport j under CRS and is an $n \times 1$ vector of weights. The non-negative weights λ measure the contribution of the efficient units selected to define a point of reference for the inefficient jth airport (see Eq. (1)). In general, $0 \le \theta_j^{\mathrm{CVS}} \le 1$, where $\theta_j^{\mathrm{CRS}} = 1$ if the airport is on the production frontier and hence technically efficient. When $\theta_j^{\mathrm{CRS}} < 1$, the airport is technically inefficient. The non-negative weights λ measure the contribution of the