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Measuring the economic efficiency of airports: A Simar–Wilson methodology analysis

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Abstract

In this paper, the innovative two-stage procedure of Simar and Wilson [Simar, L., Wilson, P.W., 2007. Estimation and inference in two stage, semi-parametric models of productive efficiency. Journal of Econometrics 136, 31–64] is used to estimate the efficiency determinants of Italian airports. In the first stage, the airports' relative technical efficiency is estimated with data envelopment analysis (DEA) to establish the airports that perform most efficiently. These airports could serve as peers to help improve performance of the least efficient airports. The paper ranks these airports according to their total productivity for the period 2001–2003. In the second stage, the Simar and Wilson (2007) procedure is used to bootstrap the DEA scores with a truncated regression. Economic implications arising from the study are also considered. Published by Elsevier Ltd.

Keywords: Airports; Italy; Data envelopment analysis; Bootstrap; Truncated regression

1. Introduction

This paper explores the use of data envelopment analysis (DEA) as an instrument for assessing the productivity driver of Italian airports. DEA identifies the efficient units, aimed to reduce wastage in airport organizations (Adler and Berechman, 2001). DEA was first developed by Farrell (1957) and consolidated by Charnes et al. (1978) as a non-parametric procedure that compares a decision unit with an efficient frontier using performance indicators.

The efficiency of airports is of interest in contemporary economics, because of their increasing strategic importance in the movement of people and cargo in the globalized world (Oum et al., 2004). Efficiency has been the focus of much research in the recent past (Fung et al., 2008; Oum et al., 2004; Pels et al., 2001, 2003; Yoshida, 2004; Yoshida and Fujimoto, 2004). Moreover, the increased competition among airlines resulting from deregulation and liberalization has placed airports in a much more competitive environment. As a result,

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airports are now under pressure to upgrade their efficiency relative to their competitors. Benchmarking analysis is one of the ways to drive airports towards the frontier of best practices (De Borger et al., 2002).

In this paper, the technical efficiency of a representative sample of Italian airports from 2001 to 2003 has been analyzed with a simultaneous two-stage procedure: in the first stage a data envelopment analysis (DEA) is used to estimate the efficient scores that rank the airports according to their efficiency (Charnes et al., 1978). In the second stage, the Simar and Wilson (2007) procedure is used to bootstrap the DEA scores with a truncated regression. This paper expands upon previous research into the airports sector by analyzing the efficiency of Italian airports with the Simar and Wilson (2007) procedure. This innovative procedure ensures the efficient estimation of the second stage estimators, compared with alternative procedures in the following ways.

First, the true efficiency score θ is not observed directly but is empirically estimated. Thus, the usual estimation procedures that assumes independently distribute error terms are not valid. Second, the empirical estimates of frontier efficiency are calculated based on the sample of airports used, which excludes some efficiency production possibilities that are feasible but not observed in the sample. This implies that the empirical estimates of efficiency are upwardly biased (Simar and Wilson, 2007). Third, the two stage procedure also depends upon other explanatory variables, which are not taken into account in the first stage efficiency estimation. This implies that the error term must be correlated with the second stage explanatory variables. Fourth, the domain of the efficient score θ is restricted to the interval zero and one, which should be taken into account in the second-stage estimation (Simar and Wilson, 2007). Overall, Simar and Wilson (2007) propose a procedure to deal with these challenges, based on a double bootstrap that enables consistent inference within models explaining efficiency scores while simultaneously producing standard errors and confident intervals for these efficiency scores. For example, an alternative bootstrap procedure adopted by Xue and Harker (1999) has been shown to be inconsistent by Simar and Wilson (1999). Related to the functional specification, it is recognized that the Tobit does not describe adequately the efficient scores. The truncated bootstrapped second-stage regression proposed by Simar and Wilson (2007) better describes the efficient scores.

Previous research on airports has been conducted by several authors using DEA, such as Adler and Berechman (2001), Barros and Sampaio (2004), Fernandes and Pacheco (2002), Gillen and Lall (1997), Murillo-Melchor (1999), Parker (1999) and Pels et al. (2001, 2003). Throughout this paper, we shall assume some knowledge of DEA on the reader's part. Readers who are not familiar with the technique are referred to Färe et al. (1994), Charnes et al. (1995), Coelli et al. (1998), Cooper et al. (2000), Thanassoulis (2001) and Zhu (2002).

The paper is organized as follows: Section 2 describes the institutional setting. Section 3 surveys the literature on the topic. Section 4 presents the methodology framework. Section 5 presents the data. Section 6 present DEA results. Section 7 presents the second-stage regression and finally Section 8 presents the discussion and conclusion.

2. Institutional setting

Forty-nine airports are registered in the Italian Statistical Register of Air Transportation, 2001–2003 (or "Relazione Sull'attività dei Aeroporti 2001–2003"), available in the Ministry of Air Transportation Infrastructure (or Ministero delle Infraestrutura e dei Transporti). This paper uses 31 airports for which balance sheet data are available in the data source, allowing the combination of financial and operational data. Thess data relate to the leading Italian airports. Table 1 presents some characteristics of the airports included in the analysis.

Passengers and freight are combined as work load units (WLU), a measure common in aviation management, measured as 1 WLU = 1 passenger = 100 kg of freight. The management status is defined by a dummy variable which is one for airports managed totally by private organizations and zero for airports managed by partial private organizations.

Naturally, this heterogeneity means that the sample contains large airports alongside small airports, based on the population density of their locations. This is a common characteristic of all airports, where the city dimension of the location is of paramount importance in attracting passengers and therefore, airlines. Relative to the managerial status, it has been verified that only the main airports are fully privatized, while the remainder operate under a mixed regime. In the latter case, the Managing Director is a public appointee who manages the airport by outsourcing its activities to private enterprises. Let us explain this private-mixed regime situation.