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Scale economies and marginal costs in Spanish airports

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ABSTRACT

In this paper, we estimate alternative specifications of the Spanish airports' cost function with the objective to provide a comparative analysis on several technological features such as output-specific marginal costs, economies of scale, and the Allen elasticities of substitution. We found evidence of significant and unexhausted scale economies as well as technological development in the Spanish airport industry. The results suggest that traffic consolidation in multi-airport areas such as the Basque Country or Catalonia will result in lower costs for the public operator.

1. Introduction

Airports have been (and still are, in many cases) under public ownership and have been commonly seen as natural monopolies which do not compete with airports in other regions or cities. They were supposed to produce efficiently and apply optimal prices in the interest of the community. Nowadays, however, airport ownership and regulation structures vary widely around the world, and several new managerial approaches are recognized. The impact of airport ownership on cost efficiency was addressed by Oum et al. (2008), which showed that for-profit airports are more efficient[3] than those under other forms of governance and that mixed ownership with a government majority should be avoided in favor of even 100% public airports.

The widely established consideration of transport activities as public services led authorities and regulators to gain interest in issues such as optimal pricing and industry structure. In the airport industry, the choice of any pricing alternative has a direct effect on demand and congestion, and if prices are not optimally set, false capacity investment signals in the long run may be present. The growing economic importance of airports and the budget restrictions imposed by governments on infrastructure investment explain, to great extent, the interest in airport pricing policies. In the same line, main regulatory decisions upon industry structure are usually based on the correct identification of the degree of returns to scale. In such sense, the estimation of cost functions is a suitable approach if adequate data is available.

The econometric estimation of cost functions using aggregated output has been used mainly to analyze the cost structure of the industry, notably whether or not there are economies of scale. These are important for assessing the feasibility of

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[3] In this paper, we suppose that all the airports operate efficiently because we are more interested in dealing with the issue of economies of scale and marginal costs. However, we are aware that our restricted model is somewhat limited in this sense, as other methodologies which impose other restrictive assumptions. For example, DEA imposes constant return to scales and provides misleading results for airports that do not operate at minimum efficient scale. Some other researchers estimate variable factor productivity assuming also constant returns to scale and excluding airport size as an important variable in the calculations. A further discussion of these issues can be consulted at Morrison (2009).

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competition between firms of different size, and the long-run equilibrium of an industry (Oum and Waters, 1996). In the present case, the estimation of the Spanish airports' cost function is aimed at addressing the questions: how many airports would optimally serve a certain region? Will multiple airport systems (MAS) be a better solution to serve a region like Catalonia or the Basque country? Do economies of scale exist? If so, to what extent, or when they are exhausted?

The rest of the paper is organized as follows. The next section describes the econometric issues of the paper. A brief literature review on the estimation of cost functions in the airport industry is discussed in Section 3. The Spanish airport database is described in detail in Section 4, which also focuses on the subject under study: AENA, as the public corporation that owns and manages most of the Spanish airport system. The estimated cost function parameters, from three alterative specifications, are presented and discussed in Sections 5 and 6 summarizes the major findings of this study.

2. The econometric estimation of airports' cost function

The economic theory asserts that economies of scale and marginal costs can be obtained from the industry's cost function. The cost function is defined as the minimum expenditure incurred by the firm to produce the output set Y at input prices ω given actual technology. Thus the firm faces the following problem:

$$\begin{aligned} &\underset{X}{Min}\,\omega X' = \omega_1 X_1 + \cdots + \omega_r X_r \\ &s \cdot t \cdot F(X, Y) \geqslant 0 \end{aligned} \tag{1}$$

where X is the set of inputs.

The solution of (1) is represented by the vector of conditional input demands $X^* = X^*(\omega, Y)$. The cost function is obtained by replacing X^* on the previous objective function, i.e. $C(\omega, Y) = \omega_1 X_1^*(\omega, Y) + \cdots + \omega_r X_r^*(\omega, Y)$, resulting in a long-run (LR) cost function, provided that all inputs may vary in the time period considered. If some inputs are fixed, then the short-run (SR) variable cost function $VC(\omega_v, Y, \bar{X})$ could also be obtained by only considering variable factor prices.

The estimation of C requires observations on costs, outputs and input prices associated to firms whose behaviour is assumed to be cost-minimizing. Some functional form has to be postulated in the stochastic specification of the cost function. Of all functional forms tested over the last 30 years, the transcendental logarithmic "translog" (Christensen et al., 1973) is the most frequently used. It provides a local second order approximation to any cost structure and allows a great variety of substitution patterns. Linear homogeneity can be imposed via linear restrictions to the parameters. It presents this general structure (LR):

$$\ln TC = \alpha_o + \sum_j \alpha_j \ln y_j + \sum_i \beta_i \ln w_i + \sum_i \sum_j \gamma_{ij} \ln y_i \ln w_j + \cdots \frac{1}{2}\left[\sum_j \sum_h \delta_{jh} \ln w_j \ln w_h + \sum_i \sum_k \rho_{ik} \ln y_i \ln y_k\right] + \varepsilon_i \tag{2}$$

In addition, the usual practice is to deviate all explanatory variables from an approximation point (usually the mean of the sample). This procedure allows a simple calculation of outputs' cost elasticities (η_j) and the Hessian values (ρ_{ik}), which are essential in identifying scale economies (S) and cost subadditivities (Jara-Díaz, 1983).

The degree of global economies of scale S is a technical property of the productive process which is defined in the transformation or production functions. However, dual relations allow the calculation of S directly from the cost function (Panzar and Willig, 1977) as:

$$S = \frac{C(\omega, y)}{\sum_i \frac{\partial C(\omega, y)}{\partial y_i} y_i} = \frac{1}{\sum_i \eta_i} \tag{3}$$

Analogously, the inclusion of an indicator of capital stock in the short-run variable cost (VC) function allows the calculation of economies of capacity utilization (ECU). Following Caves and Christensen (1988), ECU are defined as the proportional increase in VC resulting from a proportional increase in outputs, holding capital fixed.

$$ECU = \frac{VC(\omega, y, K)}{\sum_i \frac{\partial VC(\omega, y, K)}{\partial y_i} y_i} = \frac{1}{\sum_i \eta_i^{VC}} \tag{4}$$

The translog cost equation is linear in parameters and susceptible to the application of least squares regression techniques. Nevertheless, the translog cost function is commonly estimated jointly with its cost minimizing input cost share equations (obtained via Shephard's lemma) by means of a seemingly unrelated regression (SURE), and using maximum likelihood estimators (Zellner, 1962). This procedure allows researchers to include $(r-1)$ additional equations to the cost function where r is the number of inputs that have been considered in the model specification.

$$s_i = \frac{w_i X_i}{C} = \frac{\partial C}{\partial w_i} \frac{w_i}{C} = \frac{\partial \ln C}{\partial \ln w_i} = \beta_i + \sum_{j=1}^{m} \delta_{ij} \ln w_j + \sum_{j=1}^{s} \gamma_{ij} \ln y_j \tag{5}$$

Additionally, if time series data is available, a time trend (t) is incorporated into the model in order to account for technical development in the airport industry.