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Marginal costs estimation and market power of German airports[☆]

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ABSTRACT

From a theoretical prospective, marginal costs are one of the main determinants of pricing policy. However, their complexity and to some extend the artificiality of marginal costs makes the concept very unpopular among practitioners, also in the aviation industry. Nevertheless, in this paper we aim to estimate cost functions for German airports and derive marginal costs for different types of aircraft using them. This allows us to make efficiency comparison for aeronautical activities. Moreover, using the results of Morrison (1982), we are also able to estimate the "*k*" coefficients of the Ramsey-pricing formula and then use it as a proxy for market power of these airports. As the result we obtain two rankings from the sample: the first is the cost efficiency ranking of airports, and the second ranking is with respect to market power.

1. Introduction

While welfare economics suggests setting prices of regulated monopolies according to marginal costs to maximize economic welfare (first best solution), marginal-cost pricing will result in losses if average total costs are above marginal costs (Mankiw, 2008). The optimal pricing strategy for airports, which are often considered natural monopolies, is a multi-sided question that is related to this issue. While the theorists argue that the optimal pricing scheme for airports should be marginal cost pricing, or in case of associated losses Ramsey pricing, in reality the charges of the airports are close to average costs (Carlsson, 2003). The explanation of this gap between theory and practice is therefore important.

In this paper, we will concentrate on estimation of marginal costs for German airports. This exercise is extremely complicated, as even the pricing experts from the industry have difficulty identifying the correct level of marginal cost for a specific aircraft type, as such marginal costs are difficult to estimate. In contrast to the manufacturing sector where one talks about the cost of additional output, the marginal costs of serving an additional flight at an airports are much more difficult to be summed up physically and economically. Moreover, some quite contradicting approaches to estimate such marginal costs have been used in the literature.

For instance, Morrison argued in the paper "The Structure of Landing Fees at Uncongested Airports. An Application of Ramsey Pricing" (1982) that marginal costs of the airports are represented and equal to the authorities landing fee, which was $10 in 1982 for US airports, while Hogan and Starkie (2004, Chap. 5) carried a much more detailed study of the runway maintenance costs for Dublin airports through calculating tire damage for the runway and their allocation to different types of aircraft.

In the current paper, we use an econometric approach that was also used by Carlsson (2003), who calculated marginal costs for Swedish airports. The other econometric study on estimation of marginal costs of the airport is by Link, Götze, and Himanen (2009). They used hourly, daily, weekly and monthly data to estimate short run marginal costs for different periods (different congestion levels) in the airport of Helsinki-Vantaa airport. Our approach is closer to the one of Carlsson (2003) as we also consider airports long run marginal costs. First we estimate long-run cost function for the aeronautical activities[1] of the airports. We should mention that some of the cost of the airports, for instance management costs, could not be separated into aeronautical and non-aeronautical cost. That is why we first estimate the aeronautical

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[1] We separate these activities from non-aeronautical activities, i.e. retail, food and beverages, parking and car rental activities etc.

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costs of airports, and then build a cost function, depending on the number of aircraft movements, number of passengers and total freight carried. One can argue that our approach is limited, as it assumes separation of aeronautical and non-aeronautical costs of the airports, but by doing this we avoid the bigger problems of explaining total airport costs *e* by having to look at all the airport output, which is hard to determine on the non-aeronautical side of the airport. Having estimated aeronautical cost functions for the airports allows us to obtain marginal costs for a particular type of aircraft. These costs are long-run marginal costs.

In the second part of the paper we use our estimation to compare the degree of market power, the airports use in the current charges. We use the parameter of the Ramsey pricing function, to rank airports according to the market power used in the charges. Noticeably, our market power rankings of the airports, which use pure numerical approach, highly correlated with the results of Malina (2006) who uses more qualitative approach. This robustness suggests the value of methodological tool that we provide.

The rest of the paper is built as follows: first we present the overview of the data and conduct estimation of the cost function. In Section 3 the level of marginal cost are estimated and discussed. In Section 4 we estimate market power, and finish the paper with discussion and concluding remarks.

2. Data overview

We use the data from the German airport performance project GAP, which were originally collected from Eurostat.com, from balance sheets of German airports and the database of airport charges assembled by Nachrichen fuer den Luftverkehr (NFL).

The structure of the database is the following: Our database is a balanced panel of 9 German airports (Bremen, Cologne, Dortmund, Düsseldorf, Hamburg, Hannover, München, Nürnberg, and Stuttgart) for the years 1998–2007. The airports were chosen from the criterion of data availability for the largest German commercial airports.[2]

The following variables are included in the database: Number of movements, Number of Passengers, Cargo (in tonnes), number of work load units (WLU), Total costs, Aeronautical revenues, Non-aeronautical revenues, Stuff costs, Other operating costs, Inflation, Capacity of the runway, Aeronautical charges for 2007 (i.e. pdf file of charges manuals).

3. Estimations

3.1. Marginal costs

Our approach is based on an econometric estimation of an airport cost function. In this process, we use a corporate finance approach, rather than the typical one used by the economists, that usually looks at the short-run marginal costs of airports from physical damage, like harm of runway with every additional landing (Hogan & Starkie, 2004) or explain seasonality of number of employees during the seasons or even within the day time (Link et al., 2009). Our approach is a broader one, as we assume that labor cost as well as all other aeronautical costs can be divided statistically in variable and fixed part in the process of estimation of the cost function. Only these costs are appropriate to calculate Ramsey charges, which could then be compared with total aviation charges leveled by the airports (both weight and passenger based).

The main problem of this approach is that airports do not report aeronautical and non-aeronautical costs separately. The only information we could obtain from the company balance sheets was total operational costs, depreciation, labor costs. None of these can be direct approximation for aeronautical costs. To estimate them we have to assume a constant revenue margin on both aeronautical and non-aeronautical sides.[3]

Thus we have the following formula to estimate aeronautical costs:

$$\text{Aeronautical costs} = \text{Total costs} \cdot \frac{\text{Aeronautical revenues}}{\text{Total revenues}}$$

The data structure is the following:

Dependent variable: Total aeronautical costs of the airport form 1998 to 2007 (Source: Eurostat). In following when we speak about total cost we mean total aeronautical costs, for simplicity. Explanatory variables: PAX, Cargo tons, Total number of movements, Dummies for airports, inflation (fixed effects).

Previous references have used constant marginal costs across all the aircraft types, but we believe that using different marginal costs seems to be more reasonable approach, as costs can vary with number of passengers and the MTOW of the aircraft.

Table 1
Estimation of the cost function/2SLS estimation of ln (TC_aeronautical).

IV estimation of log of total costs (other operating costs, labor costs, capacity	Coefficient	*P*-value
Log of number of passenger	0.218	0.001
Log of cargo volume	0.11	0.000
Inflation	4.34	0.000
Dummies for the airports	+	

3.2. Empirical results

We estimate the econometric model with all regressors that are reported above (as explanatory variables).

As the numbers of passengers, together with amount of cargo, are both highly correlated with number of aircraft movements, our results exclude of the number of movements from the regression.

Thus the final cost function for aeronautical costs has the following representation:

$$TC = c_1 PAX^{c_2} \text{Cargo}^{c_3} \tag{1}$$

where c_1 includes general efficiency, influence of inflation and individual fixed effects.

First, we estimated model (1) using an OLS estimation in logs. But we find endogeneity in the model, as regressing explanatory variables on the residuals of the model provided significance of the coefficients. That is why an instrumental variable estimation was performed, where the following variables were used as instruments for our model: staff costs, other operating costs, WLU, annual capacity of runway.

The estimation of the cost function (using two-stage least squares estimator, random effect) was conducted in STATA 11 and results are presented in Table 1.

[2] Originally, Berlin airports (Tegel, Tempelhof and Schönefeld) and Frankfurt airport (Fraport group) were also included in the sample, but due to the fact that balance sheets of the Berlin airports and the Fraport group do not separate their individual airports, we had to exclude them from the sample.

[3] This is a strong assumption, but we failed to find any references in the literature of how else to estimate it.