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Estimating the marginal costs of airport operation using multivariate time series models with correlated error terms

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A B S T R A C T

This paper explores insights about marginal airport costs that can be gained by analysing labour inputs and their variability. Based on hourly cost and traffic data for the airport of Helsinki, a multivariate time series approach is used incorporating correlated error terms to account for random shocks such as delays. We found for most airport services a linear relationship between labour input and aircraft movements, except for producing passenger services for international departing flights where a cubic cost relationship was estimated. The findings are comparable with earlier studies for US airports.

1. Introduction

The marginal cost pricing of infrastructure has become a central issue in European transport policy (European Commission, 1998, 2001). Implementation requires estimates on the different cost components of marginal costs including maintenance, repair, renewal and operation, environmental, congestion and accident costs. We focus on the estimation of air transport infrastructure costs in this context.

The majority of cost function studies in aviation have been motivated more by deregulation issues in the airline industry than by attempts to estimate infrastructure costs and marginal costs.[1] Only a few studies have dealt with the costs of airport infrastructure services (Doganis, 1996; Morrison and Winston, 1989). This paper conducts an econometric study of Helsinki airport. While previous work was based on a standard formulation of cost functions that link costs of production to output, production factors and input prices, our analysis focuses solely on one factor input, labour, which is the dominant cost component for Helsinki airport. It analyses the relationship between labour input and aircraft movements on an hourly basis using multivariate time series analysis.

2. Modelling issues

Developing methodologies to estimate marginal infrastructure costs have not been a central issue in transportation research in Europe, although more recently, EU initiatives on marginal cost pricing of infrastructure use have produced some interest (Link and Nilsson, 2005). Two main approaches can be distinguished. The important role of wear and tear costs in road and rail transport led to a tradition of engineering-based approaches that establish a functional relationship between infrastructure damage and traffic load using physical measurements of infrastructure condition.[2] An alternative is the econometric analysis of observed spending for infrastructure maintenance and renewal and traffic load deploying cost functions that identifying the dependency of the costs of producing goods or services on output and on input prices so as to derive marginal costs.[3]

In developing the econometric model, several generic characteristics of airports need to be considered. First, terminal infrastructure differs considerably from link-based infrastructure with respect to the relative importance of specific cost categories and input factors. While, for example, road costs are characterised by a high share of wear and tear costs, costs of terminals such as airports or ports include a high proportion of operating costs, and a high share of labour costs. Airport costs are typically 75% staff costs, and these are what are focused on here. The major concern is the extent to which the number of airport staff varies with aircraft movements and passengers. It is assumed that maintenance, repair and renewals of terminals as well as non-staff related airport operation (electricity, runway lighting and signalling, tower

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[1] Examples include Baltagi et al. (1995), Barla and Perelman (1989), Caves et al. (1984), Encaooua (1991) and Windle (1991).

[2] The most prominent example for this approach is the AASHTO road test (Highway Research Board, 1961). A more recent engineering-based study can be found in Lindberg (2002).

[3] Applications of this approach for road and rail can be found in Johansson and Nilsson (2004), Gaudry and Quinet (2003) and Link (2006).

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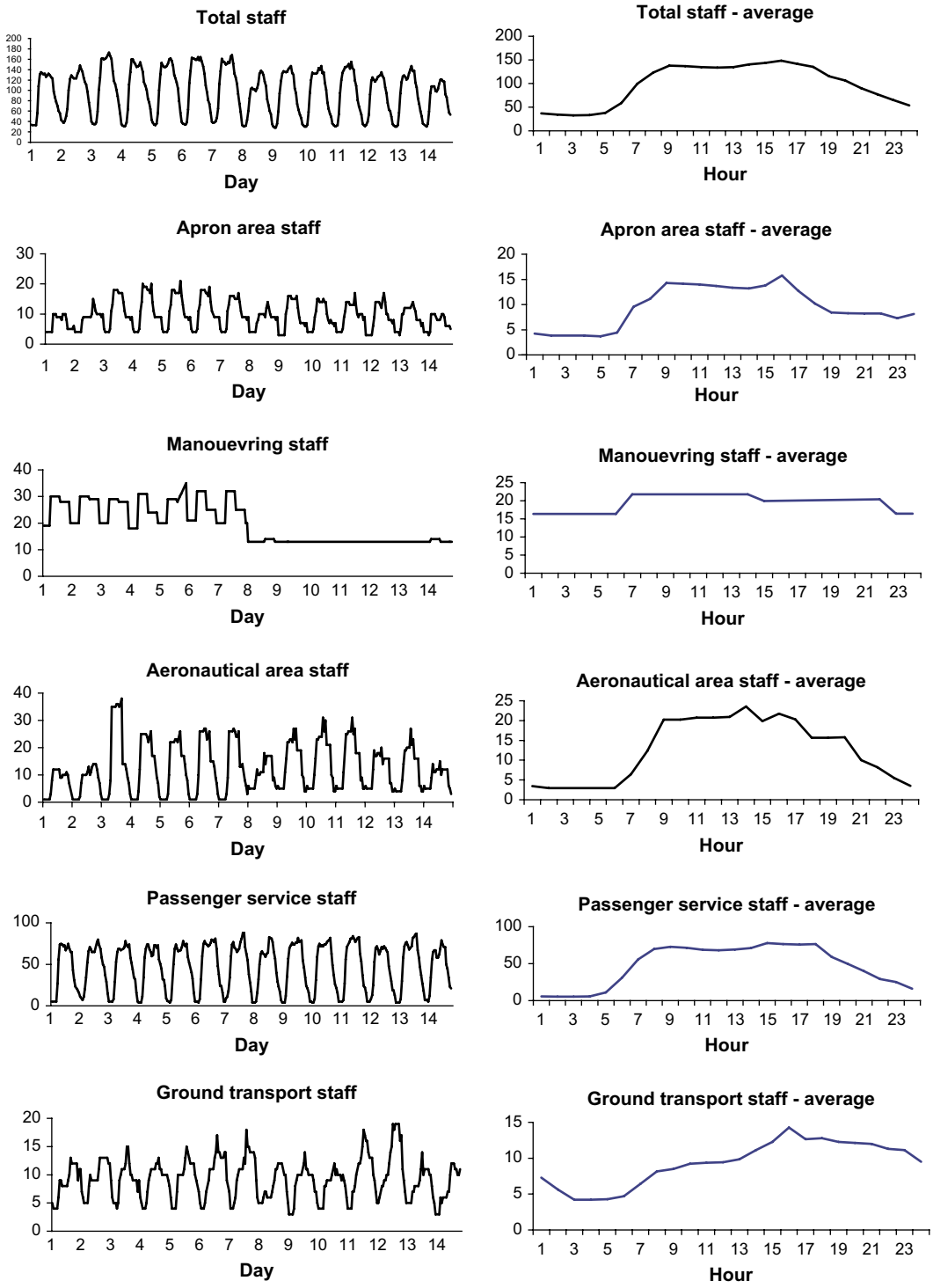

Fig. 1. Hourly variation and 14 days average hourly variation of labour inputs at Helsinki airport.

control, cleaning) are to a large extent fixed, rather than marginal costs.[4]

A second set of issues relates to which production factors are variable and to what extent labour is divisible. The degree of variability is time dependent and the hourly units used here reflect a very short-run horizon. Explorative analysis reveals considerable variations in labour input between days and within days on an hourly basis[5] for almost all service areas of the airport (Fig. 1). The data refer to hourly staff-schedules for each service area of the airport. Furthermore, variability and divisibility of staff at Helsinki airport are associated with a high share of outsourcing. We

[4] An exception is the maintenance and renewal costs of runways where similar cost-traffic load relationships as for roads can be assumed, e.g. Hayhoe (2004) and Hayhoe (2006).

[5] An exception is the manoeuvring area where particularly during winter, staff numbers do not vary much from hour to hour.