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The efficiency of public transport operations – An evaluation using stochastic frontier analysis

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ABSTRACT

The aim of this study is to evaluate the efficiency of public transport operations undertaken in Swedish counties by the Public Transport Authorities (PTA), taking into account the substantial differences in operating conditions between counties. The analysis will be performed using Stochastic Frontier Analysis (SFA) with annual data from 1986 to 2009 for 26 Swedish counties. The analysis shows how the efficiency of the individual counties has changed over time. The results are used to provide a ranking (in terms of efficiency) of the Swedish public transport authorities that can provide a basis for benchmarking. It is concluded that the efficiency of the public transport providers in all counties fell during the observed time period. Defining cost efficiency as the ratio of minimum cost to observed cost, the overall (average) cost efficiency for the industry fell from 85.7% in the eighties to 60.4% for the period from 2000 to 2009. Possible explanations for the development include increased emphasis on route density as well as higher environmental and safety requirements.

1. Introduction

In a time of increasing concern about global warming and other environmental problems, increased public transport usage is often advanced as part of the solution. In Sweden, as well as in many other countries, public transport is heavily subsidized and controlled by public authorities (Button, 2010). Subsidization and public control can be justified on theoretical grounds, for the optimal price level and structure result in financial deficits. In other words, left unregulated, the market would provide less public transport at a higher price than the optimal (i.e., social welfare maximizing) (Jansson, 1984; Ljungberg, 2010; Small & Parry, 2009).

However, there is much evidence of what can be called regulatory failure, rather than market failure, in situations where the public sector provides a service itself or regulates an industry. Public officials do not always act in the best interests of the public. They may instead try to fulfil their own self-interest and/or be under the influence of interest groups (e.g., Buchanan & Tullock, 1962; Mueller, 2003; Niskanen, 1971). It may also be that the industry they are operating within, or trying to regulate, is so complex that it is hard to process the information and actually find the optimal solution.

In a working market environment, firms operating inefficiently eventually disappear either because of competition or by being bought by someone able to increase their efficiency and thus increase profits. This is obviously not the case with public operations. However, in a time where many countries are in a fiscal crisis, there is increased concern about public sector deficits and the need for efficient use of public funds is apparent. The demand for public funds appears limitless and politicians are hard-pressed not to raise taxes or divert money from other deserving needs such as education, healthcare, childcare or eldercare. Thus it is important to continuously evaluate whether current public transport subsidies are being used optimally.

The aim of this study is to evaluate the efficiency of public transport operations undertaken in Swedish counties by Public Transport Authorities (PTA), taking into account the substantial differences in operating conditions between counties. The choice of evaluating the PTAs in terms of efficiency is due to the fact that in the Swedish public system the PTAs make the decisions on fares, network design, frequency and what kind of vehicles that are to be used etc. The operators actually driving the vehicles operate under gross contracts and have no influence over the design of the system.[1] In terms of Macario (2001) the Swedish system can be characterized as one in which the authorities have almost all

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[1] They of course influence performance of the system by being good or bad at keeping the time table set by the PTA, having drivers that are perceived as nice etc.

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influence and initiative and the operators almost none (see also Hansson, 2011, who discuss the dominant influence of the PTAs in the Swedish system). The analysis will be based on annual data from 25 Swedish counties[2] from 1986 to 2009. The results will be used to rank Swedish public transport authorities in terms of efficiency in order to provide a basis for benchmarking.

Efficiency can be defined and analysed in a number of ways. The theoretical foundation for two commonly used methods of analysis, Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA), can be found in economic theories of production. Both DEA and SFA provide information on how economic agents transform inputs into outputs, i.e., they reflect different aspects of production technology. Briefly, DEA uses mathematical programming (non-parametric) methods to identify the highest output levels that can be obtained (or are obtained by the observed producers) by combining different inputs. In SFA a production function (or its dual, a cost function) is estimated using econometric (parametric) methods in order to identify the highest possible production levels that can be attained given the available production technology (or the lowest cost of providing a production level given the price of inputs used in the production process) (e.g., Bogetoft & Otto, 2010; Coelli et al., 2005; Färe et al., 1994).

Both approaches have been applied to different parts of the transport sector. Recent applications of DEA to the performance of airlines can be found in Barbot et al. (2008), Barros and Peypoch (2009), Bhadra (2009), Merkert and Hensher (2011), and Ouellette et al. (2010). Examples of DEA applications to the rail industry can be found in Coelli and Perelman (1999), Merkert et al. (2010) and Rivera-Trujillo (2005). Recent applications of DEA to public transport operations include Hirschhausen and Cullmann (2010), Odeck (2008), and Söderberg (2009). Overviews of earlier results can be found in De Borger et al. (2002).

De Borger et al. (2002) also provide an overview of SFA applications to public transport operations. A more recent example of an application using a stochastic production frontier method is provided in Lin et al. (2010). Other examples of stochastic cost frontier applications can be found in Cambini et al. (2007), Dalen and Gomez-Lobo (2003), Jørgensen et al. (1997), Karlaftis (2010), Piacenza (2006) and Sakai and Shoji (2010). Cambini et al. (2007) also includes an overview of previous applications.

The present study will be based on an unusually long period of time in which the Swedish public transport sector underwent a series of important changes likely to affect performance. One of the most important was the movement from in-house provision of all services in 1986 to procurement through competitive tendering of almost all traffic by the end of the observation period (Hansson, 2010a).

2. Public transport in Sweden

In 1979 a major organizational reform of the Swedish public transport sector took place. It was a reform that since then has had a profound impact on the workings of the local and regional public transport system. It required a PTA to be established in each county. The PTAs are most commonly owned by the municipalities and the county council jointly, and were up to the beginning of 2012 responsible for the coordination of public transport operations in the counties. (Act 1978: 438). In 1985 the PTAs were also given the responsibility of issuing licenses for operating public transport services within the county and in practice meant that they had the options of (1) performing the services themselves, in house, acting as an operator themselves or (2) contracting out the service to private companies. In this context, it should be mentioned that before the reform of 1979, public transport services were provided by a mixture of private and publicly owned firms. Before 1960 the sector was dominated by private companies operating without subsidies but increased costs and rising car ownership resulted in many of them being taken over by municipality owned companies during the 1960s and 1970s. These companies (including the municipally owned) all operated independently without coordination of fares and service (Alexandesson 2010; Jansson & Wallin 1991).

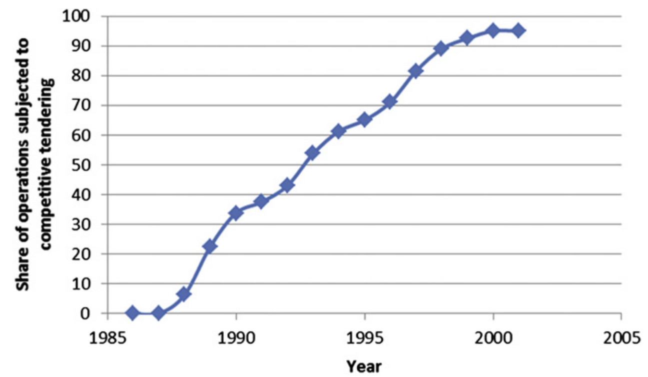

Fig. 1. The proportion of local/regional public transport in Sweden subjected to competitive tendering. (Source: Alexandersson, 2010).

The most important change in 1979 was that the fares were coordinated and subsidized through the PTAs (Alexandesson, 2010; Jansson & Wallin 1991). After 1985, the PTAs gradually started to implement competitive tendering of the operations. Fig. 1 shows the development of proportion of services subjected to tendering. Since then the proportion has remained around 95% with some municipalities still operating some special services and school transports themselves (Alexandersson, 2010).

Despite relying on private companies to perform the actual operations, the PTAs have retained all network planning as well as decisions on frequency and fares. They have also regulated what kind of vehicles that should be used and what standard they should have. The operators have worked under gross contracts with no influence over actual operations (Alexandesson, 2010). It has been suggested that this might be a source of inefficiency in the system since the knowledge of the market held by the operators is not utilized in order to optimize services. Alexandersson et al. (1998), Alexandersson and Pyddoke (2003) and Sonesson (2006) examine the effects of competition on the costs and draw the conclusion that although initial decreases in costs can be seen from tendering there is no evidence of any long run effects on costs. From 1986 to 2009 the average level of subsidy increased from 54% to 61% (for further descriptions and discussions on the organization of Swedish public transport se e.g., Hansson, 2010b).

3. Cost theory and efficiency analysis

In general terms, the cost function shows the minimum cost of producing a given quantity of output from the available inputs. Costs are therefore expressed as a function of output level and factor prices, i.e.,

$$C = C(W, Q) \tag{1}$$

where W is a vector of input prices and Q is the level of output (or a vector of output levels if a multiple output technology is

[2] As will be explained, changes in regional organisation in Sweden meant that some of these counties ceased to exist at some point during the observed time period.