Transportation Research Part E 89 (2016) 133–150

Contents lists available at ScienceDirect

Transportation Research Part E

journal homepage: www.elsevier.com/locate/tre

Understanding overall output efficiency in public transit systems: The roles of input regulations, perceived budget and input subsidies

K. Obeng, R. Sakano, C. Naanwaab *

North Carolina A&T State University, USA

ARTICLE INFO

Article history:
Received 18 August 2015
Received in revised form 28 January 2016
Accepted 3 March 2016
Available online 28 March 2016

Jel classification:
H21
H25
R48

Keywords:
Operating and capital subsidies
Transit regulations
Budget size
Overall productive efficiency
Efficiency decomposition

ABSTRACT

This paper examines the combined effects of subsidies, regulations and perceived budget on overall output and technical efficiency in a sample of single-mode bus transit systems using an indirect production function. The main findings are that the average transit system is 67.21% output efficient and systematic and stochastic technical inefficiencies decrease output. In addition subsidies increase output, regulations decrease output and the overall budget effect is an increase in output. Additionally, it identifies the characteristics of two groups of transit systems whose perceived costs after subsidies and regulations are either less or greater than actual total costs.

1. Introduction

Allocative distortions may arise from taxation increasing the perceived costs of an input relative to others, market imperfections changing the prices of some inputs relative to others, the expense preference behaviors of management, or government regulations and input subsidies distorting the prices of some inputs relative to others. The effects of allocative distortions to firms' operations have been studied individually by source and have been applied to regulated industries, such as utility, financial, and transportation industries. In reality, these sources of allocative distortions affect firms differently and may enhance or counteract each other. This study attempts to analytically derive and apply the division of sources of allocative distortion to the transit industry, focusing in particular on three sources: subsidies, regulations, and net budget after subsidies and regulations (perceived budget effect). In public transit systems, there are two types of input subsidies: operating and capital subsidies. These subsidies are often supported because they satisfy social objectives, such as "preserving the vitality of cities, creating a better urban environment, and keeping fares low for the underprivileged" (Altshuler, 1981). In addition, transit services reduce traffic congestion in urban areas and improve residents' quality of life; as such, they should be budgeted for and supported by public transit subsidies. Despite their appeal, the empirical support

* Corresponding author at: Department of Economics, North Carolina A&T State University, 117 Merrick Hall, 1601 East Market Street, Greensboro, NC 27411, USA. Tel.: +1 336 285 3351.
E-mail address: cbnaanwa@ncat.edu (C. Naanwaab).

http://dx.doi.org/10.1016/j.tre.2016.03.001
1366-5545/

for some of these justifications is often mixed, especially regarding the congestion reduction effect of subsidies because of the very low cross-elasticity between transit and auto trips.

This lack of uniform support is not limited to the reasons for subsidies alone but also to their effects on public transit performance. For example, Karlaftis et al. (1999) found that local subsidies had positive effects on the performance of transit systems of all sizes but that federal subsidies only had beneficial effects on small and medium-sized transit systems. By contrast, because subsidies reduce the focus on cost control, it has been argued that transit systems are not incentivized to operate efficiently. This line of thinking is supported by Piacenza (2006), who found that fixed-price subsidies distort operating costs, and by Kim and Spiegel (1987), who found allocative distortions from lump-sum subsidies in terms of the higher employment of capital and increased costs. Nolan (1996) found that U.S. transit systems that received large state subsidies had less incentive to produce efficient outputs. In addition, Obeng (1994) found that operating and capital subsidies increased costs by 2.2%, while Sakano et al. (1997) found that subsidies resulted in technical and allocative inefficiencies in terms of the excessive use of labor relative to capital and the excessive use of fuel relative to labor and capital. However, compared to other factors, subsidies accounted for less than 25% of the allocative inefficiencies in urban transit systems.

The effects of subsidies on the productivity of transit systems were also studied by Kim and Spiegel (1987), who found a decrease in average productivity due to lump-sum subsidies. Adding to these results, Obeng and Sakano (2000) found that capital subsidies increased total factor productivity (TFP) by 1.48% per year, operating subsidies decreased TFP by 1.04% per year, and subsidies increased TFP overall. In subsequent research, Obeng and Sakano (2008) found that when diseconomies of scale were present, the lump-sum and substitution effects of these subsidies reduced TFP. On the other hand, Margari et al. (2007) found that, in Italian transit systems, fixed-price subsidies increased production efficiency by increasing risk sharing.

Along with subsidies, U.S. transit systems are regulated by numerous federal laws and rules, which are intended to partially offset some of the adverse effects of subsidies on transit operations and performance. These regulations include a restriction on the minimum number of years that a vehicle bought with federal subsidies should be in service (12 years); a spare bus ratio of 20% if the buses are bought with federal monies; an incentive tier for the federal operating subsidy formula, which rewards transit systems for higher outputs and penalizes them for high operating costs; and regulations related to the treatment of employees whose jobs are affected by capital purchased with federal funds (i.e., Section 13(C) of the Federal Transit Administration Act). Although the effects of regulations have been studied in many other industries, they have not received much attention in the public transit economics literature.

An exception is the regulation related to the purchase of some transit services from private sector sources (contracting). The initial research of Morlok and Viton (1985) on contracting found that a private carrier's cost per mile for providing transit services was 50–60% that of a public carrier's cost in the U.S. and 50–65% that of a public carrier's cost in Australia and England. When competitive bidding was used for contracting, they also found 50% cost savings from using a private carrier to provide transit services. Despite these cost savings, later work by Iseki (2008) found that the benefits of private sector involvement in public transit provisions depended on the type of contracting arrangement used. Compared to transit systems that did not use contracting, Iseki found that those fully contracting out their services experienced rapid increases in the cost per vehicle hour and that those using partial contracting had lesser increases in the cost per vehicle hour. Complementing these findings are those of Roy and Yvrande-Billon (2007), showing that, in France, private transit operators with management contracts were less efficient compared to private operators with fixed-price contracts. In India, state-owned transit systems that must comply with regulations to provide transit services were found to have the highest rate of productivity growth, followed by companies not owned but controlled by state and local governments (Kumbhakar and Bhattacharyya, 1996). For Spain, Albalate et al. (2012) studied governance and regulation of urban transportation with particular reference to Barcelona and found that incentive-based contracts resulted in increases in passengers, revenues and service quality. Finally, in China, Zhang et al. (2015) found that gross contracts improved technical efficiency than net cost and management contracts.

However, these studies have failed to examine how regulations, in making transit systems use or avoid specific inputs and deviating from optimal input allocation, affect output and overall output efficiency. This overall output efficiency is the proportional difference between the maximum output that can be produced with fixed input levels and the actual output produced—a difference that results from allocative and technical inefficiencies and random errors. A regulated transit system, which faces certain requirements and constraints, internalizes the allocative costs of regulations in its decisions and perceives its private costs as higher because it must exert endogenous efforts (e.g., service and equipment changes, increased supervision and monitoring) to follow the regulations. These studies also overlook how the interactions of input price deviations from market prices due to regulations and subsidies and induced budget changes from subsidies and regulations affect output and performance. In part, these omissions exist because previous studies treated transit output as exogenous in cost functions. Hence, these studies did not examine the effects of regulations and subsidies on output and failed to recognize the effects of the budget on output, which will be more pronounced under scale (dis)economies. However, when regulations seek to "achieve the policy goal of public service obligation. . .it is relevant to consider production levels as not being exogenous in the determination of costs" (Urdanoz and Vibes, 2013). Such endogeneity also applies to U.S. operating and capital subsidies in terms of their relationships with input levels because they are known proportions of input costs.[1] As such, their sizes are

[1] For example, federal subsidies cover 80% of the costs of new buses, new rail cars, tracks, right-of-way acquisition, other equipment, facilities, fuel and labor for construction, etc., and operating subsidies cover 50% of operating losses on the margin.