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Operational performance of U.S. public rail transit and implications for public policy

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ABSTRACT

In today's tough economic environment, governments at all levels face significant budget shortfalls and public rail transit systems must compete with other public services for government subsidies. It is critical that public rail transit systems be concerned with their operational performance and efficient use of resources. In this paper, we develop a methodology that measures a rail transit system's performance relative to that of other rail transit systems, compares its performance to an appropriate efficient benchmark system, and identifies the sources of its inefficiency. We analyze the relationship between public subsidies and operational performance of public rail systems and show an inverse relationship between subsidization and efficiency.

1. Introduction

Public commuter rail transit plays a vital role in modern society in the U.S [1]. In 2011, U.S. public commuter rail systems transported over 464 million passengers [2]. In addition, they also provide other benefits to society. For example, public commuter transit systems are estimated to save $1.9 billion per year by mitigating traffic congestion and $1.7 billion per year by avoiding traffic-related injuries and fatalities [3]. These systems also save $263 million per year by mitigating environmental degradation costs and enable economic development by providing jobs for about 443,000 people while spurring regional businesses and property development [4].

For its operations, every public commuter rail transit system in the U.S. relies heavily on government subsidies [5]. Indeed, on average more than 50% of public commuter rail operating expenses are subsidized by local, state, and federal governments [6]. Presently, governments at all levels face significant budget shortfalls and public commuter rail transit must compete with other public services for financial support [7]. Therefore, it is critical for public rail transit systems to become more economically viable and depend less on public financial support. They need to do this while dealing with rising energy and labor costs.

To accomplish this, public commuter rail transit systems must (1) raise fare revenue or (2) reduce operating costs, or both. However, increasing fares may lead to reduced ridership thereby making the transit system less effective, and may also lead to reduced fare revenue [8]. Hence, transit systems need to optimize their service effectiveness and focus on cost reductions through increased operational efficiency. To improve operational efficiency, transit managers must identify the sources of inefficiency within their systems. The existing literature on efficiency measurement does not include a model that meets this need, leading to the first research question: (i) What is an appropriate efficiency measurement model that identifies the sources of operational inefficiency in each U.S. commuter rail transit system?

Subsidies tend to change the behavior of producers (to produce more) and consumers (to consume more), but they act to resist the pressure of competitiveness in an organization [9] [10]. Subsidized organizations have reduced incentive to improve their productivity, minimize costs, and maximize revenue; hence, those organizations tend to become less innovative and less efficient [11] [9]. Therefore, from a public policy perspective it is important to investigate the role of public subsidization of operating expenses on the operational efficiency of the U.S. commuter rail systems. Thus, a second research question arises: (ii) What is the effect of public operating subsidies on the operational efficiency of U.S. commuter rail transit systems?

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Previously, some researchers such as Wachs [12], Oum and Yu [11], Cantos et al. [13], and Graham [14] claim that the efficiencies of public rail transit systems have been negatively impacted by increased dependence on government subsidies. Cervero [15] examines the effects of subsidies on the performance of 17 California multimodal transit systems and finds that the subsidies degrade the transit performance over time. Karlaftis and McCarthy [16] show an inverse relationship between public transit systems' performance and public subsidies in Indiana. However, none of this research applies directly to U.S. public commuter rail systems.

In this paper, we test the research hypothesis that public operating subsidies reduce the operational efficiency of U.S. public commuter rail transit systems. Operating subsidies data are available, but we need to measure the operational efficiency of each U.S. commuter rail system using an appropriate methodology.

This study addresses these research questions by developing a mathematical model that identifies the sources of inefficiency within each U.S. commuter rail transit system and measures the operational efficiency of each system. This research allows transit managers, funding agencies, and policy-making bodies to understand the sources of poor operating performance and set realistic goals to improve public rail systems. Furthermore, the proposed model can be used as a tool for operational decision-making, for the development of regulatory policy, and for the determination of operating subsidies.

2. Background

Heretofore, researchers have evaluated the efficiency of various U.S. rail systems. Caves et al. [17] compare the economic performance of Canadian and U.S. Class 1 freight railroads by their rates of growth and relative levels of total factor productivity (TFP). They find that the less regulated Canadian railroads have far higher productivity growth rates than the more regulated U.S. railroads. Bookbinder and Qu [18] use Data Envelopment Analysis (DEA) to compute the efficiency scores of Class 1 freight railroads in North America in 1989. They use the results to compare U.S. and Canadian freight railroad performance. In a similar study, Chapin and Schmidt [19] use DEA to measure efficiency of U.S. freight railroads to assess deregulation policy and railway mergers. Karlaftis and McCarthy [16] perform factor analysis on public transit systems in Indiana and find that three attributes – efficiency, effectiveness, and overall performance are essential to describe a transit system's performance. Martinez and Nakanishi [20] use DEA to determine efficiency scores for U.S. heavy rail systems from 1984 to 1997. They find that certain operating conditions are significant than others and report than the average efficiency of U.S. heavy rail is 76%. Chu et al. [21] propose three single-ratio DEA models to measure efficiency of U.S. public multimodal transit systems. Karlaftis [22] determines the efficiency and effectiveness of 256 U.S. multimodal transit agencies and reports that they are positively correlated. However, neither Chu et al. nor Karlaftis attempt to identify the sources of inefficiency within each operator. Fielding et al. [23] propose the Irvine Performance Evaluation Methodology (IPEM) as a methodology that allows an agency to compare its performance with that of similar agencies using multiple ratios. However, IPEM does not provide a single overall measure of transit performance and does not identify the sources of inefficiency. The U.S. Bureau of Labor Statistics uses a multifactor productivity (MFP) measure for the U.S. rail industry. The MFP measure is not specific to an individual transit mode nor does it provide any deeper insight about the sources of inefficiency.

Several researchers have evaluated efficiencies of various rail systems outside the U.S. Hensher et al. [24] use DEA to assess the efficiency of Australia's public rail systems from 1972 to 1992. Oum and Yu [11] use DEA to calculate the efficiency of 19 railways, one each in 19 OECD (Organization for Economic Co-operation and Development) countries. They use the results to evaluate the effects of government intervention on railway efficiency. They do not include U.S. rail systems in their study. Levaggi [25] applies DEA to 55 urban transport companies operating in Italy. Kerstens [26] uses DEA to measure the efficiencies of French urban transit companies and provides explanations of respective inefficiencies. Cantos et al. [13] use the Malmquist productivity index along with DEA to compute the efficiency of European railways from 1970 to 1995. They use the results to analyze and understand the determinants of efficiency. Gathon and Pestieau [27] examine 19 European railways from 1961 to 1988 by decomposing traditional measures of productive efficiency into a management and a regulatory component. They imply that the management is responsible for just managerial inefficiency and government is responsible for slacks in regulatory efficiency. Cowie [28] specifically examines Swiss private railways using a DEA framework to assess the privatization of railways. Coelli and Perelamn [29] use production and distance functions to measure and compare the performance of 17 European railways from 1978–1983 to 1988–1993. They claim that the TFP growth of European railways improved during the 1980s, primarily due to reduction in labor usage and rolling stock, which are most likely a consequence of stricter government budgetary restrictions and constraints upon the level of government subsidies [29]. Similarly, Cantos and Maudos [30] show the growth in productivity of European railways from 1970 to 1990 using Stochastic Frontier Analysis (SFA). They find a negative correlation between cost efficiency and revenue efficiency. Cowie and Riddington [31] investigate various efficiency measurement methodologies such as DEA, Corrected Ordinary Least Squares, Bayesian State Space techniques, etc. They conclude that efficiency of a railway system primarily depends on its management. Similarly, Oum et al. [32], in their extensive survey, analyze various methodologies used for measuring and comparing the efficiencies of railways. They find that railway managerial autonomy positively affects efficiency. Parisio [33] measures technical and cost efficiencies of 8 European railroads from 1973 to 1989 by using a stochastic cost frontier model. Results suggest that cost savings could be obtained by reducing the amount of resources devoted to production such as, reducing staff and downsizing some unprofitable branches of the rail line [33].

More recently, Jain et al. [34] use DEA to conduct a comparative analysis of 15 urban rail transit systems from 1992 to 2002 across the world (no U.S. rail systems were included) and to analyze the relationship between ownership structure and technical efficiency. They contend that the policies and ownership structures of urban rail transit systems have an impact upon their efficiency. Ramanathan [35,36] constructs a DEA framework to determine the efficiency of rail and road transport in India. The author uses the results to assess various government policies in areas such as energy, environment, and subsidization. Brons et al. [37] carry out meta-analysis of efficiency measures of urban public transit throughout the world. They find no statistical difference in the efficiency ratios estimated by parametric and non-parametric methods. Graham [14] formulates and compares the efficiency results of 200 urban railways throughout the world by using DEA and TFP. The author identifies differences in the results and proposes an alternative approach to mitigate the inconsistencies. Hilmola [38] studies public rail transportation systems in 52 large cities around the world using DEA. The author finds that public rail systems in large cities are not necessarily the most efficient ones. Teng et al. [39] examines policies of Chinese freight railway operations from 1984 to 2007 using DEA. Jitsuzumi and Nakamura [40] apply DEA to 53 Japanese railway