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Fare evasion in public transport: A time series approach

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ABSTRACT

An econometric model is presented that identifies the main variables explaining evasion of fare payment on a public transport system. The model uses a cointegration approach. The model parameters are estimated using data from the Santiago (Chile) bus system, where evasion has been measured at approximately 28%. The main results of the model are that (i) a 10% increase in the fare raises evasion by 2 percentage points and (ii) a 10% increase in inspections lowers evasion by 0.8 percentage points. An increase in unemployment, the third explanatory variable in the model, tends to induce a decrease in evasion, and vice versa. This counterintuitive finding may be explained by the fact that those most vulnerable to job loss, and more likely to evade than the average user due to economic necessity, tend to reduce their use of the bus system when unemployment rises and increase it when unemployment falls.

Our results suggest a revision of the evasion control policy in Santiago to improve its effectiveness, and to link inspection efforts to fare increases or to decreases in unemployment.

1. Introduction

Evasion of fare payment on public transport is a major problem for many bus and tram systems around the world that have not implemented an effective method of enforcement. As well as the ethical issues it raises, evasion can, if unchecked, become a major contributor to an operating deficit. In the case of Transantiago, the operator of an integrated transit system in Santiago, Chile, evasion is particularly common on the buses, where it has risen to about 28%, or more than one in four users. This is in stark contrast with the system's Metro network, where non-payment is no more than 0.2%.

Existing works on the phenomenon have focussed on the effectiveness of countermeasures in various specific contexts. To our knowledge, no previous publications have attempted to formally model the impact of potentially relevant factors on evasion. With the intention of filling this gap, the present study develops an econometric model that attempts to explain the long-term aggregate relationship between fare evasion and a set of variables that includes the amount of the fare, fare enforcement and unemployment. Changes in these variables as well as their absolute levels were considered. The data sets used to estimate the model are time series and as such, they may be non-stationary in the sample. This means the series must be checked for cointegration to ensure the regression estimates are not spurious.

The explained variable in the proposed formulation is monthly evasion (i.e., the percentage of users per month who evade fare payment) while the precise explanatory variables are the logarithm of the fare, the logarithm of the number of fare pay-

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ment inspections (as a measure of fare enforcement), and the corresponding monthly unemployment rate in percentage terms. The errors are modelled as an autoregressive-moving average process (ARMA). The variable parameters are estimated by maximum likelihood using heteroscedasticity-robust variance-covariance matrices.

The main results of our model, estimated using data from the Transantiago bus system, indicate that an increase in bus fares leads to an increase in evasion while an increase in enforcement generates a slight decrease. A positive relationship was also found between evasion and unemployment, suggesting that those most vulnerable to job loss, and more likely to evade than the average user due to economic necessity, tend to reduce their use of the bus system when unemployment rises and increase it when unemployment falls. These specific findings and the proposed analysis of the determinants of evasion generally should be useful in helping transport system authorities to design better mechanisms for dealing with the public transit evasion problem.

The remainder of this article is organized in three sections. Section 2 reviews the literature on fare evasion in public transport; Section 3 describes the data, introduces the proposed models and presents the estimates generated; and Section 4 sets out our conclusions and their implications for public transport operation and subsidy policies.

2. Survey of the literature

Considering its importance for public transport finance and policy, fare evasion has received relatively little attention in the literature. The magnitude of the problem is reflected in the evasion rates for a number of transit systems around the world set forth in Table 1. As can be seen, with the exception of Reggio Emilia in northern Italy, the incidence of evasion in Europe is lower than that reported by Latin American cities. Santiago, Chile, the case study for the present article, has the dubious honour of topping the list with an evasion rate of 27.6%.

Much of the published research on evasion attempts to elucidate the reasons behind it, focussing on different attributes of both the evaders and the transit systems where the problem is particularly acute. Often cited are certain aspects of individual and social behaviour that might lead to evasion. The ultimate causes seem to lie in multiple factors such as passenger income, perceptions of service quality, fare payment methods and the behaviour of other passengers (Reddy et al., 2011; Bucciol et al., 2013).

Smith and Clarke (2000) note that fare evasion has legal repercussions much like other crimes or acts of dishonesty committed on public transport that may target other passengers, employees or the system itself. A recent paper by Guarda et al. (2016) uses a disaggregated negative binomial count regression model with cross-sectional data to identify operating factors in the Santiago, Chile bus system that impact non-payment of fares. The authors found that evasion increases with the number of passengers (level of occupancy), the number of passengers boarding/alighting at a given door and wait times at bus stops.

Delbosc and Currie (2016) conduct a quantitative analysis based on a survey of 1561 residents of Melbourne, Australia, to characterize different types or clusters of evaders. They identify three categories: accidental (e.g., users who meant to pay but the ticket/validation machines were not working), unintentional (e.g., users who meant to validate but were in a hurry or forgot) and deliberate (e.g., users who decided not to pay because they were only going a short distance). The authors also briefly discuss the impact on evasion of different measures that have been adopted to combat it.

Polinsky and Shavell (1979), Boyd et al. (1989) and Kooreman (1993) propose theoretical approaches based on microeconomic modelling, assuming that evaders are rational actors who consider only the cost of the fares and the likelihood of being caught. The models take no account of the social context in which evasion occurs or of non-monetary penalties such as social sanctions (e.g., publishing the names of evaders).

Departing somewhat from the focus of the present article, Barabino et al. (2013) considers the issue of efficiency in fare inspection, examining factors such as the proportion of riders checked, the amount of evasion and transit system operator earnings. They find that the level of fines for evasion and the way they are collected both influence the cost-effectiveness of inspection efforts. According to Clarke et al. (2010), however, it is not clear what would be the optimal balance between the level of inspection and the size of the fine to reduce evasion to a minimum, or what might be the minimum achievable evasion level.

In a similar vein, Killias et al. (2009) report that the majority of public transport systems base their anti-evasion strategies on ticket inspection and fines for evaders. Bonfanti and Wagenknecht (2010) recommend that transit operators provide the requisite working conditions so that system staff can act as inspectors, though this role may be rejected at the political level or by the employees themselves. Gino et al. (2009) describes the influence of group dynamics, emotions and situational context in an attempt to better understand fare evasion as one type of unethical behaviour.

Regarding determinants of public transport demand, Paulley et al. (2006) offer a review of how fares, quality of service, income and car ownership affect the demand for public transport. In the same line, Cordera et al. (2015) study the demand for public transport during the economic cycle in the city of Santander, Spain. They find that recessionary periods with higher unemployment and lower income increase the demand for public transport.

Barabino et al. (2015) investigates evasion in Italy, where interest in the issue is growing due to the role it plays in transit operators' financial losses, social inequities and increasing levels of violence towards system personnel and other riders. Another recent paper, by Tirachini and Quiroz (2016), surveys the literature on the causes of evasion and makes a series of recommendations and suggestions for reducing it.