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How can public transit get people out of their cars? An analysis of transit mode choice for commute trips in Los Angeles

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ABSTRACT

U.S. public transit agencies struggle to attract and retain riders. Unprecedented public investments have been made over the past several decades for expanding and improving transit service across cities. Unfortunately, however, there is no evidence of increase in ridership once growth in population and aggregate travel demand are accounted for. Consequently, the quest for boosting patronage continues. The challenge, experts argue, is to attract people out of cars.

In this paper, I use a recent state-wide travel survey from California and take advantage of a new comprehensive historical archive of regional real-time multi-modal transportation system data to explore contexts in which persons belonging to car-owning households within Los Angeles County use transit for their commute.

I find that few car owners use transit, and that lack of access to the household vehicle(s) explain choice of transit to a large extent. While discretionary transit use (or transit use by choice) is rare, I find evidence that fast (relative to car), frequent and reliable transit service along with fewer transfer requirements strongly correlate with car-owners' transit mode choice. Home and workplace neighborhood density, proximity to transit stop, and availability of rail are other critical facilitators. Even if observed effects are due, in part, to self-selection, there are important lessons for transit planners. For example, results suggest that all else equal: reduction in transit-to-auto travel time ratio by unity can increase odds of transit mode choice by about 25%; reduction in headway by 10 min can increase the odds by about 30%, and; lowering the standard deviation of schedule deviation from over to under three minutes can result in 2.6 times increase in the odds.

This paper identifies effective strategies for increasing transit's competitiveness relative to auto, and hence attracting people out of their cars. While rail network expansion programs and transit-oriented development efforts must continue across U.S. cities, it is important that planners also advocate for investments in key dimensions of bus service quality that patrons value, such as speed, frequency and reliability. Efficient network designs that reduce transfer requirements, introduction of bus rapid transit services, and improvements in real-time operations, scheduling and long-range planning by using ITS (intelligent transportation systems) infrastructures across modes are critical. This study shows that careful planning can promote discretionary transit use by attracting existing latent demand and by creating new demand in an era of increasing government interest in transit and growing traffic congestion. Broader positive effects on the travelling public and the environment are much greater than what this study can predict.

1. Introduction

U.S. federal, state, and local governments have been investing to expand and improve public transport infrastructures across metropolitan regions. Figures from the Federal Transit Administration's National Transit Database (NTD; see www.transit.dot.gov/ntd) reveals that between 1991 and 2012, total annual government spending on transit steadily increased from $22 billion to $58.5 billion at an inflation-adjusted cumulative annual average growth rate (CAGR) of 2.2%. Over the same period, total vehicle revenue miles of service increased from 2.5 to 4.0 billion miles at a CAGR of 2.3%.

Increasing investments, however, have not been proportionately translated into increased ridership or productivity. For example, the number of unlinked passenger trips per revenue vehicle hour, the industry-standard measure of service effectiveness, decreased from 46.5 to 39.4 over the 1991–2012 period (NTD). Also, fare-box recovery ratio (fare revenue as % of total operating expense) decreased from 36.4 to 33.1 over the same period (NTD). Those mean lower produc-

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tivity and higher subsidy requirement for transit operations in general.

Transit is indeed a relatively small player in the U.S. travel market. Repeated nation-wide estimations of mode use for commuting using various survey instruments (Decennial Census, American Community Survey, National Personal Transportation Survey, and National Household Travel Survey) over the past decades have revealed that transit's share is stagnant at about 5%. If all trip purposes are considered, the share drops further (Santos et al., 2011).

Key to increasing transit's market share, particularly in the U.S. context, is attracting people out of cars (and simultaneously containing attrition of transit riders who can own and/or use a personal vehicle). Effective goal-oriented policy formulation requires better understanding of who among *people with choice* use transit and under what conditions they find transit use feasible. This might help identify where latent transit travel demand exists, and how planners might tap into that demand.

This paper examines the personal characteristics of choice riders themselves, and the conditions (e.g. service qualities of transit, traffic conditions via the auto mode, neighborhood built environments, etc.) under which they are attracted towards transit. By controlling for factors that might restrict access of a car-owning individual to the household vehicle, I identify spatial contexts, along with characteristics of the multi-modal transportation network, in which transit succeeds in attracting discretionary riders. Discretionary transit use refers to transit use by choice throughout the paper.

I analyze usual mode choice to work for persons (age 16+) living and working in Los Angeles County. Access to a comprehensive historical archive[1] of regional real-time multi-modal transportation system data provides a unique opportunity to offer the first empirical evidence on how service quality differences among alternate modes available for the journey to work influence, in part, transit mode choice over other available modes.

Findings suggest that not all car owners who use transit for commuting are discretionary riders – absence of valid driving license and presence of more workers than cars in the household are influential factors that limit access to auto and induce transit use. But the transit users (some of whom could be discretionary riders) are younger on average, and that the level and quality of transit availability and connectivity influences their location and travel choices. A regression analysis underscores the association of fast (relative to auto), frequent, and reliable transit service (home-to-work) with discretionary transit commuting. For example, results suggest that all else equal: reduction in transit-to-auto travel time ratio by unity can increase odds of transit mode choice by about 25%; reduction in headway by 10 min can increase the odds by about 30%, and; lowering the standard deviation of schedule deviation from over to under three minutes can result in 2.6 times increase in the odds. Interestingly, there is no evidence that increasing congestion or unreliability of the auto mode independently increases the demand for transit.

The rest of the paper is organized as follows: I first summarize past empirical work on factors determining transit mode choice. Second, I introduce the study area and outline the research approach. Third, I present analyses with planning-policy discussions. Finally, I list the study limitations and conclude the paper with policy implications.

2. Literature review

Based on consumer choice theory, travelers are assumed to rationally choose a travel mode by evaluating (through experience/perception or by analyzing data/information) the characteristics of various available competing alternatives in an attempt to maximize personal utility (de Donnea, 1972; Domencich and McFadden, 1975). Since utility cannot be observed directly, utility-based models estimate the probability that a given alternative (with an expected utility based on its own attributes, and the attributes of the individual making the choice) will be chosen by observing how people actually behave, or by capturing their stated choices in hypothetical scenarios.

Transport policy relies on the idea that travel choices can be influenced/altered, and broader social goals such as congestion- and pollution-reduction may be achieved, by implementing policies that change relative costs of different modes. But mode choice (particularly for routine travel such as the commute) is often a relatively longer-term (hence rather inelastic) choice, made through careful assessment of conditions that are both internal (e.g. travel time and cost budgets determined by personal, household, and work-related constraints) and external (e.g. multi-modal transportation network factors) to the commuter, and that is governed by a complex set of personal attitudes, preferences, habits, culture, lifestyle, and physical (dis)abilities. We know that choice is often governed by inflexible personal attitudes that may not be as sensitive to costs as we expect. Schneider (2013) notes that mode choice for routine travel may be driven by habit. While this potentially makes auto to transit mode shifts challenging, a study by Vredin Johansson et al. (2006) suggests that an enduring shift to more socially desirable modes of travel may be possible even without direct economic incentives. Perhaps, change in transport-related dogmas along with improved access to public transport at a reduced cost can promote transit use (Collins and Chambers, 2005).

Researchers have found it difficult to determine and generalize how travelers perceive costs associated with particular modes, and how they might react to changes. Consequently, identifying an exhaustive list of parameters determining mode choice, and collecting appropriate data to measure them, has always been challenging (Cervero, 2002). Past mode choice models lack consistency in specification, and data availability and research agenda drive parameter choices in modeling.

The desirability of public transit and, consequently, its choice over the car depends upon its competitiveness in the urban passenger travel marketplace. In countries such as the U.S., where automobile travel has historically been cheap, shared modes of transportation have struggled to attract users. In the U.S., public transit currently caters largely to those with low incomes who have limited means of owning or using an automobile (Pucher and Renne, 2003; Santos et al., 2011). In other countries such as Great Britain (Giuliano and Dargay, 2006) and Germany (Buehler, 2011), where auto transport costs are higher due to the land use and pricing policies, alternative transport modes such as transit are relatively more popular.

Consistent with expectations, empirical studies generally indicate that conditions that are directly associated with relatively increasing the cost of auto travel (with respect to transit) – such as high auto parking price (Gillen, 1977), road use charges (Washbrook et al., 2006), lower levels of transit-to-auto travel time and/or out-of-pocket cost (Asensio, 2002) – are also associated with greater demand for transit, or at least lower demand for solo-driving. Direct interventions to decrease time costs and improve transit service may also boost transit choice (Forsey et al., 2013).

Decades of research has shown that people use transit more in denser, mixed-use, pedestrian-friendly, transit-accessible, vibrant station areas (e.g. refer to Cervero (1994), Chen et al. (2008), Ewing and Cervero (2010), Ding et al. (2014)). The observed association arguably operates through higher relative cost of auto travel (e.g. Crane and Crepeau, 1998). The observed effects also could be due in part to self-sorting of pro-transit individuals into areas that have good quality transit where generalized costs of transit travel relative to its competitor(s) may be low (for relevant discussions on the self-selection issue refer, e.g.: Schwanen and Mokhtarian, 2005). The self-sorting issue means that new transit supply may not change travel behavior. Nevertheless, the idea that more transit supply will change mode choice has had major influence on local land use policy with coordinated land use – transit planning. Chatman (2013) surveyed house-

[1] Los Angeles County Metropolitan Transportation Authority-funded Archived Data Management System (ADMS) developed at the University of Southern California.