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The influences of past and present residential locations on vehicle ownership decisions

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ABSTRACT

This study explores the relationship between historical exposure to the built environment and current vehicle ownership patterns. The influence of past exposure to the built environment on current vehicle ownership decisions may be causal, but there are alternative explanations. Households may primarily select to live in neighborhoods that facilitate their vehicle ownership preferences, or they may retain preferences that they have developed in the past, irrespective of their current situations. This study seeks to control for these alternative explanations by including the built environment attributes of households' past residences as an influence on vehicle ownership choices. We use a dataset from a credit reporting firm that contains up to nine previous residential ZIP codes for households currently living in the 13-county Atlanta, Georgia, metropolitan area. Results show that past location is significant, but of marginal influence relative to the attributes of the current location. From a practical perspective, our results suggest that models that include current but not past neighborhood attributes (also controlling for standard socioeconomic variables) can forecast vehicle ownership decisions reasonably well. However, models that include both current and past neighborhood attributes can provide a more nuanced understanding of the built environment's potentially causal influences on vehicle ownership decisions. This better understanding may provide more realistic forecasts of responses to densification or other travel demand management strategies.

1. Introduction

Society's dependence on private vehicles creates several negative externalities. From an economic perspective, traffic congestion cost the U.S. economy $121 billion in lost wage productivity in 2011 (Schrank et al., 2012). Economic externalities from vehicle dependence may be even more pronounced among certain demographic groups; for instance, the reduced ability of low-income households to obtain vehicles is often viewed as a factor contributing to low economic mobility (Leonhardt, 2013; Matas et al., 2009). In addition, a large portion of urban air pollution is due to transportation-related emissions and can contribute to global climate change (Chapman, 2007), respiratory ailments in the general public (Buckeridge et al., 2002), and other negative externalities.

Previous studies have explored relationships between vehicle ownership decisions and the built environment (e.g., Dieleman et al., 2002; Ewing and Cervero, 2001; Giuliano and Dargay, 2006; Van Acker and Witlox, 2010). These studies have

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hypothesized that households who live in denser or more mixed-use areas can access a larger number of activity locations by walking, biking, or taking public transit, reducing the need for one (or more) vehicles. Policies designed to increase densities or land use mix are therefore often viewed as mechanisms for reducing vehicle ownership and/or vehicle usage, which in turn would help reduce emissions (Kenworthy and Laube, 1996; Norman et al., 2006; Stone, 2009), potentially alleviate congestion, and improve transportation equity (Sanchez et al., 2003).

To isolate the autonomous influence of the built environment on vehicle ownership decisions, it is important to control for other possible causal influences. On one hand, self-selection could explain part of the observed correlation between the built environment and travel behavior; that is, individuals who prefer to own fewer vehicles may choose to live in denser or more mixed neighborhoods *so that* they can own fewer vehicles. Density in this situation facilitates, rather than causes, a particular behavior. If this is true, then incentivizing or requiring density through zoning or tax policies may not change vehicle ownership in a meaningful way, *unless preferences also change*. On the other hand, however, individuals' preferences for vehicle ownership may, in fact, evolve over time as they are exposed to more dense and mixed neighborhoods and learn about non-vehicle transportation options. If this is true, then building denser or more mixed-use developments could eventually lead to lower levels of vehicle ownership, although the short-term effectiveness of using density as a planning tool for positive environmental and economic changes could be diminished.

In this study, we use multinomial logit models to predict the (non-zero) number of vehicles owned by a household as a function of the head of the household's socioeconomic characteristics, current neighborhood density (defined as housing units per square kilometer in the ZIP code) and the current neighborhood's use of non-vehicle transportation modes (as indicated by the ZIP code's non-vehicle commuting mode share). To this base model we add variables that characterize the head of household's historical *exposure* to both density and non-vehicle transportation alternatives (using the same definitions for each metric). We use the results to assess the practical implications of omitting prior built environment information in vehicle ownership choice models.

Our study is distinct from the majority of prior studies reported in the literature in that we use data from existing third-party sources (namely prior addresses and socio-demographic information maintained by credit reporting firms) to explore these research questions. Our paper contributes to the literature by demonstrating how existing data sources can be mined to explore nuanced questions, such as which functional form representing the influence of prior residences best fits models of vehicle ownership. However, because we use existing revealed preference data, we are unable to explicitly model the role of attitudes and preferences on vehicle ownership decisions, as prior studies based on household surveys have been able to do.

The paper is organized into several sections. Section 2 describes how our study relates to and contributes to the literature, presenting a conceptual model of vehicle ownership response to a change in residential location. Section 3 provides an overview of the analysis database and data processing assumptions. Sections 4 and 5 follow, presenting the econometric methodology and results, respectively. Section 6 discusses the practical implications of the results, and Section 7 presents study limitations and directions for future research. The paper concludes with a summary of key findings and implications for practice. An Appendix A details the results of sensitivity tests we conducted to verify the robustness of results to different data processing and modeling assumptions.

2. Literature review

Many forecasting models used in professional practice view vehicle ownership as a strictly utilitarian phenomenon. In this perspective, a given household has a need for vehicles established by the size of the household (or its number of workers) and the availability of vehicle alternatives (which, in turn, is a function of the built environment). The household acquires the necessary vehicles subject to income constraints (as an example, see Potoglou and Susilo, 2008). In contrast, a growing body of literature shows that attitudes and preferences play a significant role in vehicle choice and use. Some people have a propensity to own vehicles that are faster or more stylish than strictly necessary (Lois and López-Sáez, 2009). Others choose vehicles that signal environmental–political preferences (Sexton and Sexton, 2014). More generally, it has been shown that people tend to own vehicles that are similar to those driven by their neighbors (Adjemian et al., 2010).

Separating the effects of these attitudes from the effects of the built environment is difficult, as people select their built environment based at least partially on these attitudes. Studying this *self-selection* problem has become an important research objective in transportation behavior modeling. Cao et al. (2009) and Mokhtarian and Cao (2008) extensively review the literature on self-selection, and Cao and Cao (2014) give a recent presentation of self-selection in a vehicle ownership context. Handy et al. (2006) and Pinjari et al. (2009) likewise address environmental self-selection, though in transportation contexts other than vehicle ownership. Self-selection may be addressed in a vehicle ownership model by considering the vehicle choice and residential location choice as occurring simultaneously (e.g., Eluru et al., 2010; Roorda et al., 2009), through structural equations modeling (e.g., Bagley and Mokhtarian, 2002; Cao et al., 2007b), or by including attitudes as exogenous variables when they can be observed.

For example, Cao et al. (2007a) surveyed 547 households that had recently (in the previous year) moved into a group of Northern California neighborhoods representing either traditional or suburban land use characteristics. These characteristics included indicators such as the age and style of homes, street connectivity, and distance to various commercial establishments. The survey asked the households about their current and previous vehicle ownership levels as well as their attitudes toward travel behaviors (e.g., "I need a car to do many of the things I like to do") and neighborhood design (e.g., "I prefer shopping areas within walking distance"). The authors showed that these attitudes were more predictive of household vehicle ownership than