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Do your neighbors affect your bicycling choice? A spatial probit model for bicycling to The Ohio State University

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ABSTRACT

Neighborhood social effects have recently become a focus of interest in transportation research, whereby transportation mode choice is not only affected by an individual's characteristics and transportation system conditions, but also by the mode choices of that individual's social neighbors. This study supports the neighborhood social effects argument, using a spatial econometrics approach and data from The Ohio State University (OSU) 2012 Campus Transportation Survey. A spatial probit model of commuters' mode choices (bicycling versus non-bicycling) is estimated, accounting for spatial autocorrelation. The results show that the more OSU-affiliated bicycle riders are residing around an individual OSU commuter, the more attractive bicycling becomes, controlling for other factors such as gender, status, proximity to campus, bicycle infrastructure and attitudes. The results indicate that students and males are more likely to commute by bicycles. The probability of choosing bicycles decreases with distance from campus. In addition, proximity to bicycle infrastructure and physical environment both encourage respondents to bicycle. Feeling of safety, travel cost and concern for the environment also affect bicycling choice.

1. Introduction

Interest in reducing car use for commuting is increasing across the U.S. Decision makers in several metropolitan regions have been trying to reduce solo driving and promote alternative modes of transportation to reduce traffic congestion, noise, and air pollution. Numerous studies have been conducted on the links between transportation patterns and built environment features, and the impacts of various TDM (Transportation Demand Management) strategies (Boarnet and Crane, 2001; Cervero, 2002; Cervero and Radisch, 1996; Handy, 2005; Schwanen and Mokhtarian, 2005). Several universities are now following these trends and encouraging alternative modes (walking, bicycling, ridesharing, and transit) because of their social and environmental benefits (Akar et al., 2012; Akar and Clifton, 2009; Balsas, 2003; Barata et al., 2011; Dorsey, 2005; Zeng et al., 2009). Regarded as a healthy commuting mode, bicycling reduces transportation expenditures and helps improve individuals' lifestyles.

Discrete choice models have long been used to analyze individual decision-making in transportation, whereby individuals maximize their utility based on their own socioeconomic characteristics and those of the available transportation systems. However, the social interactions between decision makers within a social network have not, in the past, been taken into consideration. These effects have been recently shown to explain a range of individual behaviors (Brock and Durlauf, 2001, 2002; Paez and Scott, 2007; Paez et al., 2008). The term "*neighborhood effects*" will be used here, because the social interactions are considered within a spatial context defined by maximum distances or jurisdictional boundaries (e.g., Census tracts). The basic assumption is that the more a commuting mode is used within a neighborhood, the more attractive it becomes to all commuters in this neighborhood (Goetzke, 2008; Goetzke and Andrade, 2010; Goetzke and Rave, 2011). Therefore, policies to enhance bicycling choice should focus not only on improving related infrastructures but also on promoting a bicycling culture when these neighborhood effects are significant (Goetzke and Rave, 2011; Nelson and Allen, 1997).

The study area for this research is The Ohio State University (OSU) main campus, located in Columbus, Ohio, with an area of about 7 km^2 and over 80,000 people commuting to campus. The Columbus metropolitan area has long been dominated by cars because of low population density and a well-connected highway system. The transportation infrastructure on and around campus is car oriented, encouraging people to drive cars even within distances suitable for bicycling (Akar et al., 2012). In order to change individuals' mode choices, it is important to assess the propensity

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of faculty, students and staff to choose bicycling, whether the current bicycle infrastructures and other physical environment features encourage bicycling, and finally whether neighborhood effects impact people's mode choices, asides from ordinary socioeconomic factors.

This study analyzes neighborhood effects, using data from the 2012 OSU Campus Transportation Survey. Questions cover respondents' travel modes, socioeconomic features, attitudes toward travel modes, and proximity to bicycle facilities. The survey records respondents' residential locations, providing the basis for defining spatial relationships. Built environment and land use characteristics, such as population and intersection densities, are also calculated. A spatial probit model is estimated to account for spatial autocorrelation. The results can be used to analyze the direct and indirect effects that increase an individual's probability of choosing bicycling. However, it should be emphasized, from the onset, that these effects are captured only for the OSU commuter population, and not for the larger metropolitan cycling population. While this may be viewed as a limitation, one may also argue that individuals who work or study in the same organization are more likely to interact with each other, and to observe each other's behavior more closely, as suggested by Scott et al. (2012) in the case of telecommuting decisions. Possible research avenues to capture more comprehensive and detailed social interactions are discussed in Section 6.

2. Background

With the growing interest in increasing bicycle mode share, several researchers have examined the factors associated with bicycling, including the effects of the built environment, socioeconomic characteristics of individuals and households, and the availability and type of bicycle facilities (Akar and Clifton, 2009; Broach et al., 2012; Krizek et al., 2005; Krizek and Roland, 2005; Pucher et al., 2011, 2010; Sener et al., 2009; Stinson and Bhat, 2003; Xing et al., 2010).

It is well accepted that the presence of bicycle facilities is a significant factor in attracting cyclists (Dill and Carr, 2003) and several studies focus on which facilities are the most preferred by cyclists. For instance, Tilahun et al. (2007) report that individuals are willing to increase their travel time by 20 min in order to switch from an unmarked on-road facility with side parking to an off-road bicycle trail. Observing the behavior of cyclists in Portland, Oregon, using GPS units for several days Broach et al. (2012) report that cyclists prefer off-street bike paths and bicycle boulevards, and are sensitive to distance, frequency of turns, slope and traffic volumes.

Although bicycle infrastructure is an important factor in attracting cyclists, it is not the only factor. Sener et al. (2009) report several factors associated with bicycling frequency, including demographics, residential location, season, bicycle amenities at work (bicycle racks, showers) and bicyclists' perceptions of the overall quality of bicycle facilities. Heinen et al. (2011) indicate that attitudes toward the benefits of bicycling (e.g., convenience, low cost, health) have strong impacts on bicycle commuting choice.

Pucher et al. (2010, 2011) report the importance of implementing an integrated package of measures, a combination of infrastructure provision (expanded and improved bike lanes and paths, traffic calming, parking), bike-transit integration, bike sharing, pro-bicycle programs, land-use planning, and restrictions on car use. These integrated measures help develop a cycling culture which has been cited as an important factor in bicycling decisions. Handy et al. (2010) suggest that if an individual lives in a community with a strong bicycle culture and with good bicycle infrastructure, his/her preferences for bicycling may increase over time. Xing et al. (2010) list a culture of utilitarian bicycling as a key factor for transportation bicycling, as opposed to recreational bicycling. They examine data from six cities in the Western U.S. and report the significant effects of individual, social-environment, and physical-environment factors on the balance between utilitarian and recreational bicycling and on miles of bicycling. They find that comfort, short distances to destinations, a culture of utilitarian bicycling and an aversion to driving are associated with utilitarian bicycling. Bonham and Koth (2010) state that improving safety, multi-modal issues and fostering a campus cycling culture are important elements in enhancing cycling. They argue that a visible cycling culture on campus creates its own momentum. Both non-commuter and commuter cyclists of the University of South Australia cite the necessity of creating a visible cycling culture on campus. Rybarczyk and Gallagher (2014) analyze the factors that would increase bicycling and walking activity at the University of Michigan-Flint. They identify safety, better lighting, increased automobile costs, educational classes, commuting tips, secure bicycle racks, and a visible bicycling culture as important factors. Several of their survey respondents stated that they would not bicycle unless more bicyclists were observed in their community. They interpret this finding as an indicator of demand for a bicycling culture, which will in turn incase the overall number of bicyclists.

In addition to studies based on focus groups or general populations, there is a growing literature examining travel patterns on college campuses, as the adverse effects of driving (congestion, increased parking demand, reduced physical activity) have spread to these campuses. As first stated by Balsas (2003), campuses differ from other urban areas, with their unique population of younger and more active individuals, a continuous movement of people throughout the day, and irregular schedules. He argues that the travel behavior and environmental awareness of students may spread to the whole nation over time. Thus, campuses may have a unique opportunity to help reduce overall car use. The studies of Bonham and Koth (2010) and Rybarczyk and Gallagher (2014) (discussed above) are examples of the growing literature on campus transportation patterns. Akar and Clifton (2009) and Akar et al. (2013) examine the factors associated with bicycling choice at the University of Maryland and OSU campuses, respectively, and state that, in addition to individuals' socio-demographic characteristics, proximity to destination and bicycle facilities, and attitudes toward transportation (safety, flexibility, environmental concerns and ability to make stops on the way) also play a major role in bicycling choice. Using 2011 OSU Campus Transportation Survey data, Akar et al. (2012) report that individuals prefer driving alone because of their concern for safety, travel time, flexibility of departure time, and the ability to make stops on the way, and suggest that the same level of service must be provided by alternative modes to be competitive with car use. However, they do not consider neighborhood effects – the interactions of decision makers within a given geography. In contrast, the present study, using the 2012 OSU Campus Transportation Survey data, considers these effects and focuses on bicycling versus non-bicycling choice.

Borrowing from a well-established perspective in sociology, recent economic research has started focusing on the role of social interactions in economic behavior and decision-making, particularly social interactions taking place within a neighborhood. For instance, Boldoc et al. (1995) suggest that individual utilities are likely to be spatially correlated because of the similarity of unobserved attributes in neighboring communities. Brock and Durlauf (2001, 2002) are among the first to focus on these effects within the context of discrete choices. They formulate a multinomial logit model based on an individual utility function that includes a private utility component (individual characteristics), a social utility component depending on the decisions of other individuals in