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Walking frequency, cars, dogs, and the built environment

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ABSTRACT

To explain walking propensity or frequency, empirical studies have generally used two sets of explanatory variables, namely, socio-demographic variables and built environment variables. They have generally shown that both socio-demographic characteristics and built environment characteristics are associated with walking propensity. We examine the traditional walkability variables that encompass density, mix of uses, and network connectivity in New Jersey, using a statewide sample including an oversample of Jersey City. We estimate a two-stage least squares model using a conditional mixed process that combines an ordered probit model of walking frequency in the second stage based on a truncated regression of car ownership in the first stage. Our results show that built environment variables have some small effects, mainly from better network connectivity associated with increased walking frequency. One of our key findings is that built environment features also work indirectly via how they influence car ownership. In general, we find sufficient evidence that suggests fewer cars are owned in areas with more walkable built environment features. The other key variable that we control for is whether a household owns a dog. This also proved to be strongly associated with walking suggesting that dog ownership is a necessary control variable to understand the frequency of walking.

1. Introduction

A large body of literature has examined factors associated with walking over the last two decades. This has been due primarily to concerns about increasing traffic congestion, environmental effects of increasing vehicle use, and more recently, with increasing rates of obesity in the population (Forsyth et al., 2009). Empirical studies have shown that increased walking has an association with reduced obesity (Frank et al., 2004, 2008). Concerns over climate change and finding ways to reduce car usage in order to meet climate targets are another reason for analyzing these effects (Yang et al., 2009). Much of the analysis has focused on differences between more compact areas that are more walkable versus more sprawling car-dependent areas (Ewing and Cervero, 2010).

It has been generally held that neighborhoods with features that are amenable to walking generate significantly higher volumes of walking trips (Sallis et al., 2004). Many studies have defined a walkability index to explain walking propensity and have found a significant positive association with increased levels of walking. Walkability is usually measured by combining measures of net residential density, street connectivity, and land-use mix (Frank et al., 2005; Leslie et al., 2007; Saelens et al., 2003). One reason to create an index is that the individual components are often highly correlated (Cervero and Kockelman, 1997), making decomposition of individual effects problematic. There is a large literature that has examined many of these factors. A review of the literature by Saelens and Handy (2008) shows that walking for transportation is associated with density, distance to nonresidential destinations, and land use mix. Route/network connectivity, parks and open

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space, and personal safety are less significant. There is little or no evidence for relations between transportation walking and pedestrian infrastructure conditions, traffic-related issues, aesthetics, or accessibility of facilities for physical activity.

The same review article concluded that recreational walking has stronger associations with pedestrian infrastructure and aesthetics as well as personal safety and land use mix (compared to utilitarian walking). There is little or no evidence for associations between recreational walking and density, distance to nonresidential destinations, route/network connectivity, parks and open space, traffic, and accessibility to facilities for physical activity (Saelens and Handy, 2008). Several studies have focused on walking for specific purposes such as work trips (Craig et al., 2002; Guo et al., 2007), non-work trips (Greenwald and Boarnet, 2001), and walking for recreation (Rutt and Coleman, 2005). Although studies have shown differences in the correlates associated with utilitarian walking versus for recreation, our data precludes a separate analysis of these effects. Given our interest in physical activity (to combat obesity) we are interested in overall walking similar to studies such as (Berrigan and Troiano, 2002) that also evaluated all walking trips jointly.

Several studies have previously assessed the relationship between dog ownership and walking in the broader context of the effects of pet ownership on human health. In spite of the variations in methods and results these studies draw the same conclusion that dog owners are more physically active (primarily through walking their dog) than non-owners (Bauman et al., 2001; Cutt et al., 2007, 2008a; Brown and Rhodes, 2006; Ham and Epping, 2006; Oka and Shibata, 2009; Owen et al., 2007; Serpell, 1991; Sirard et al., 2011). This association is mainly explained by the motivation and obligation to walk one's dog in addition to any other factors that support walking (Cutt et al., 2008b; Hoerster et al., 2010). While many features of the built environment that support walking in general would also support people walking with their dogs, accessibility of public open spaces and the quality of dog-accessible spaces are among the common built environment factors recognized to be conducive to dog ownership and dog walking (Cutt et al., 2008c; Coleman et al., 2008; Tilt, 2010). Our study includes an indicator variable for dog ownership that is statistically significant in all our models of walking frequency.

It has generally been acknowledged that residential self-selection explains a part of the observed walking behavior in more walkable neighborhoods; that is, individuals who prefer to walk (or do not like to drive) will choose to live in more walkable neighborhoods. This can lead to bias in estimates of the effect of building more walkable neighborhoods. There are several ways to account for self-selection, including direct survey questions (Owen et al., 2007; Frank et al., 2007), simultaneous models (Pinjari et al., 2007), and structural equation modeling (Bagley and Mokhtarian, 2002). Most estimates that attempt to control for self-selection still find an effect from built environment features on the choice of walking or frequency of walking (Pinjari et al., 2007; Cao, 2010). Some evidence exists that there is less self-selection into car-dependent neighborhoods, compared to more urban neighborhoods (Schwanen and Mokhtarian, 2005; Cao et al., 2009).

We take another approach to these issues. Our analysis focuses on the frequency of walking in New Jersey, using a statewide sample including an oversample of Jersey City, which is in the most densely populated part of the state. While we examine the traditional walkability variables that encompass density, mix of uses, and network connectivity, we do this using a two-stage least squares model that examines how these factors affect car ownership followed by an ordered probit model of walking frequency. Previous work by Bhat and Guo (2007) estimated a joint choice model of residential choice and car ownership and found that built environment variables affect car ownership. Theoretically, this is an appealing approach, as the built environment can affect the cost of car ownership, mainly through how the built environment affects the ease and convenience of driving, whether due to slower speeds in more walkable areas or more difficulty finding free or cheaply priced parking.

Our results show that the level of household car ownership is important in the choice of whether individuals walk and that car ownership itself is partly determined by many of the walkability features that typically have an association with walking. The findings show that the most significant built environment variables are the ones related to network connectivity and these affect walking behavior both directly and indirectly through the influence on vehicle ownership. Most of the socio-economic factors are only associated with vehicle ownership (with the exception of age). These findings highlight the importance of policy that affects vehicle ownership decisions; more connected walkable networks seem to be a negative factor, but other variables that increase the cost and difficulty of vehicle ownership (such as how parking is provided) can be as promising as promoting pedestrian friendly environments.

2. Theoretical framework and methodology

Our basic approach assumes that various built environment factors have an influence on the frequency of walking. As previous research has found, frequency or the propensity to walk increases due to proximity to a mix of uses (represented by land use features and density), decreased barriers to walking (as represented by a lack of network connectivity), and socioeconomic factors associated with a household. These latter have been used as controls for residential self-selection, but do not completely control for this bias (Cao, 2010). The other factors represent the generalized cost to walking; built environment features can both affect the amount of time a walk trip takes, but also the comfort, safety, and enjoyment of the walking environment. Built environment features can also affect the cost of car ownership through the ease and convenience of owning a car (or multiple cars). For example, land costs are higher in more urbanized areas and, all else equal, this would increase the cost of parking a car, although often individuals may not perceive this marginal cost (Shoup, 1997). These areas also tend to have street networks that make driving less convenient and often traffic is more congested, both increase the generalized cost of car ownership.