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Residential location and transit-oriented development in a new rail corridor

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ABSTRACT

The relationship of form, use, and density in urban development and their influence on human behavior and travel is a key element of many land use and transport policies. Prior research indicates high-density urban development leads to decreased travel and thus sustainable mobility; however, personal attitudes seem to have greater effect on mobility than does the urban form. This research evaluates how households consider transit-oriented development (TOD) characteristics in their location decisions with regard to new Mandurah railway line stations opened in December 2007 in Perth, Western Australia. The results indicate that the choice of residence reflects neighborhood and housing attributes, with significant heterogeneity in the populations of the three precincts in terms of their valuation of various housing characteristics, proximity to urban facilities, and transport. There is also significant variation in households' attitudes to natural and artificial environments. A better understanding of the complex relationships among environment, travel, socio-demographic characteristics, and household attitudes can help transport planners leverage the benefits of TOD and improve the quality of urban design and community life.

1. Introduction

The 72 km Perth-Mandurah extension to the urban rail network in Western Australia opened in 2007 to complete a direct north–south line of 105 km. Thirty km of the extension are located in a freeway median. Despite expert predictions, the low population density (5–19 per hectare in this corridor) did not prevent the success of the extension, much of it being due to park-and-ride. The only problem has been overcrowding of peak trains.

This paper deals with location choice by residents in three areas served by the rail extension, one long established, one designed around the TOD concept and one which is developing rapidly around a station but not particularly designed to exploit what it offers. The study was conducted shortly before the opening of the rail extension.

1.1. The issue and the approach

The impending construction of the line created new travel prospects for residents and new factors in location decisions which are the primary focus of the study. By modeling the impacts of spatial structure on residential location choice and travel behavior we aim to assess the effectiveness of land use policies. The main problem is to estimate the relative explanatory power of key socio-demographic attributes and attitudinal factors in determining location choice. We use a choice model to identify the separate effects of neighborhood and housing features on the one hand, and attitudes about location

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choice on the other. The location model uses data obtained in revealed and stated preference questionnaires augmented by factors for dwelling features and access to facilities, based on responses to the attitudinal questions. Modeling in three contrasting areas makes it possible to identify the intensity of the transit-oriented design (TOD) impacts. The model is formulated in Section 2, taking account of the research reviewed in 1.2, 1.3 and 1.4.

1.2. Built environment, residential self-selection and travel

There is a continuing debate in the literature on whether land use and transport policies are effective in modifying household travel decisions. In particular, policy makers would like to know if neighborhoods that are conducive to walking or to the use of public transport reduce the dependence on the automobile. Despite the explosion of empirical studies in recent decades, it is still premature to draw any conclusions about the impacts of built environments on travel behavior. Although it has been shown that mixed-land use, residential and employment density, good street connectivity and high transit accessibility all contribute to reduced auto dependence (Cervero and Duncan 2003; Handy et al., 2002; Ewing et al., 2008), there is insufficient evidence to conclude a one-way causality that the built environment modifies travel patterns (Cao et al., 2007).

Two streams of existing research investigate: (1) the impact of the built environment on residential location choice and travel behavior (Bhat and Poszgay, 2002; Cervero, 2005; Gordon et al., 1989; Khattak and Rodriguez, 2005; Næss, 2005; Salomon and Mokhtarian, 1998) and (2) the role of household structure and individual characteristics in explaining the diversity of travel and location decisions (Circella et al., 2008; Kim et al., 2007; Kitamura et al., 1997; Meurs and Haaijer, 2001; Timmermans et al., 2002; Weber and Kwan, 2003; Schwanen and Mokhtarian, 2005a,b). The latter group examines the possibility that the relationship between the built environment and travel behavior is associative and that households may choose residential locations that fit in with their travel needs. This is known as residential self-selection. A combination of the two directions is also emerging (Cao et al., 2006, 2007, 2009; Chen and McKnight, 2007; Kim et al., 2007; Prashker et al., 2008).

Bhat and Guo (2007) control for the self-selection of individuals into neighborhoods to test the causal effect of built environment measures on travel behavior. Their results suggest that residential location decisions and travel decisions are not independent. The dominant factor in the residential location decision is the household income. One self-expressed limitations of their study is that they did not include attitudinal data.

Walker and Li (2007) identify three latent classes of households in a model of residential location and discuss the differences between the classes with respect to responses to attitudinal questions. Recent applications of choice models to examine mode choice and car ownership decisions have included attitudinal variables at the estimation stage (Vredin Johansson et al., 2006; Bolduc et al., 2008). This advancement makes full use of the hybrid choice model put forward by Ben-Akiva et al. (1999). The models presented in this paper add to the literature by investigating the contribution of attitudes in a discrete choice model of residential location by estimating the degree to which the latent classes correlate with the collected attitudinal data.

Mokhtarian and Cao (2008) provide a comprehensive review of the methodological approaches to investigating the confounding residential-self selection and built environment effects on travel behavior decisions. They conclude that the use of structural equation modeling with time dependence is best suited to disentangling the confounding of residential self-selection and the effect of built environment on travel related decisions (see also Cao et al., 2007). Their main point is that the inclusion of attitudinal data as well as having before and after data (i.e. time dependence) provides the best opportunity to verify causality. The research described in this paper is part of a 3-wave quasi panel data study designed to capture the impact of a *built environment intervention* in the form of the construction of an urban rail line in a green field setting, described in Section 3. The research undertaken in this paper compares the contribution of household characteristics and location/travel attitudes to the relocation decision. Specifically we examine the differences in these variables for households recently moving to one of three types of TOD locations on the new railway. A controlled experiment is conducted to elicit preferences for household and neighborhood attributes in a residential choice setting. We adopt stated preference for its benefits: investigating a hypothetical situation on a non-existing rail line and manipulating the attributes and levels. Although revealed preference data may be considered with objective accessibility measures and dwelling characteristics, it may not capture the household perceptions of those attributes. In addition, the multitude of alternatives in the choice set creates modeling difficulties and introduces randomness in the attribute values.

1.3. Function and accessibility of TOD

Transit-oriented development (TOD) strategies integrate land use and transport functions aimed at preventing urban sprawl (Cervero et al., 2004; Newman and Kenworthy, 2006; Barton et al., 2003; Renne and Wells, 2005). The main attributes of TOD are moderate to high-density development located within an easy walk (1/2 mile or 800 m) of a major public transport stop. The land-use pattern is a mix of residential, employment and shopping opportunities designed for pedestrians and cyclists without excluding cars (Evans et al., 2007). TOD planning may apply to new construction or to redevelopment.

To identify the degree to which a neighborhood reflects TOD principles, Renne and Wells (2005) collate indicators proposed by 30 professionals; the list includes transit ridership, population/housing density and employment density, qualitative rating of the streetscape, mixed-use structures, pedestrian activity counts, number of intersections for pedestrian safety, estimated increase in property value, public transport services connecting to station, parking spaces, and convenience/