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Exploring the impact of residential relocation on modal shift in commute trips: Evidence from a quasi-longitudinal analysis



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ABSTRACT

A growing number of studies have been devoted to the effects of residential relocation on travel behavior. However, most of these studies only focus on the direct effects of personal and system characteristics; while, residential relocation may trigger several interrelated changes in activity-travel behavior and mobility resources. This paper studies the mode choice of commuters who used active transport before relocating. Results from a Bayesian network (BN) analysis, trained on retrospective data collected in Nanjing, China, are presented. The constructed BN identifies significant statistical associations between modal shift and selected explanatory variables, which include movers' socio-demographic characteristics, relocation-related attributes, and changes in built environment. Specifically, car ownership, income, additional car purchase, specific housing type and size, relocation type, change in commute distance, convenience of subway/bus for commuting, and distance to subway station are found to be important factors when deciding to switch from private car to public transit.

1. Introduction

Recently, many major cities in China have witnessed large-scale urban sprawl. The explosive population growth and the rapidly increasing and often unaffordable housing prices in city centers have caused residents to change their living environment and to relocate to the suburbs. Relocation may trigger people to re-evaluate their current activity-travel patterns and to reconsider their current choices. To the extent that residential relocation does not coincide with a parallel change of workplace, residential relocation likely involves longer commuting distances or travel times. Moreover, the pattern of suburbs is spatially more diffuse and densities are typically lower. Consequently, many suburbs are logically better fit for car use (Raphael and Rice, 2002).

Thus, people, who were active commuters (walkers or cyclists) before residential relocation, may reconsider their travel mode choice and shift to car use. In that case, suburbanization has detrimental effects on transport mode choice and therefore the environment and health. Evidence suggests that commuters who moved are more likely to change their commuting behavior than those who did not (Dargay and Hanly, 2007; Prillwitz et al., 2007). Following the outward relocation wave, the commuting distance/time of most residents living in suburban communities has increased due to the job-housing imbalance. Consequently, a motorizing trend is observed in many Chinese cities, further amplified by the raise of income levels (Cervero, and Day, 2008; Wang and Zhou, 2016). Because, compared to other countries across the world, the share of active travel modes in Chinese cities is traditional relatively high, cities in China are more likely to experience this motorization trend more intensely, with stronger negative externalities such as worsening traffic conditions, deteriorating air quality and increased energy consumption. Therefore, it is of paramount importance to understand the process of modal shift after relocation.

To investigate the determinants of behavioral change, a growing body of research has employed mobility biographies, emphasizing that key life course events, such as job change and residential relocation, may lead individuals to reconsider and even reshape their travel habits (Van der Waerden et al., 2003; Lanzendorf, 2003; Scheiner and Holz-Rau, 2013a; Oakil et al., 2016; Clark et al., 2016). This approach assumes that through learning and adaptation, people adjust their travel behavior to cope with

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Received 29 January 2017; Received in revised form 30 May 2017; Accepted 9 July 2017 Available online 27 July 2017 0967-070X/© 2017 Elsevier Ltd. All rights reserved. the difficulties they face and ultimately developed habitual activitytravel patterns. Supply conditions of the transportation system and the urban context are important factors for the definition of choice options and constraints (Rasouli and Timmermans, 2014). Over time, they develop routines that best suit their needs, subject to the constraints they face. Dramatic changes in these equilibrium conditions may trigger them to change partly or fully their activity-travel patterns. Changes in built environment seem correlated with changes in travel behavior (Handy et al., 2005; Scheiner and Holz-Rau, 2013b; Panter et al., 2014; Van de Coevering et al., 2015). However, although these studies have successfully identified general determinants of behavioral changes, only few studies have focused on modal shifts of previously active transport commuters after relocation.

Therefore, this study sets out to elucidate the complex relationship between residential relocation and modal shifts using a retrospective survey administered in Nanjing, China. The central questions to be addressed in this study are: (1) How does residential relocation affect long-term mode choice of active commuters? (2) Do socio-demographic and relocation-related characteristics of commuters before and after relocation influence transport mode choice for commuting trips of movers who used to commute by active transport modes before relocation? To answer these questions, we use a slightly more complex method of analysis than commonly applied in studies about the relationship between the built environment and travel behavior to account for the potentially complex direct and indirect relations between moving house and travel choices that may prevail. While many previous studies on behavioral change have applied statistical methods (such as probit, binary logit, and logistic regression) that allow estimating only direct effects (Dargay and Hanly, 2007; Cervero and Day, 2008; Panter et al., 2014; Oakil et al., 2016; Clark et al., 2016), the complexity of adjustments to residential relocation made us decide to construct a Bayesian network (BN). This method allows extracting direct and indirect relationships from the selected variables. An inference analysis based on the resulting network structure quantifies the impacts of these variables on modal shift.

The contribution of this paper to the literature is two-fold. First, the study adds empirical evidence to the still relatively limited number of studies on modal shifts for the work commute after relocation. Second, the focus on Nanjing, China expands the understanding of dynamics in modal shift to the relocation with respect to previous studies developed in European settings. Large cities in China are significant different from western developed regions; the populations are much larger, socio-demographic characteristics show higher variability; differences in mobility resources differ substantially. In other words, the inherently more varied geography of the location under study makes this analysis particularly relevant and offers opportunities to identify key influential factors for policy analysis and identification.

2. Literature review

This study aims to explore the relationships between modal shifts of active commuters, changes in the built environment, socio-demographics and relocation-related attributes in a relocation context. Using a socioecological framework, we consider three types of factors that influence long-term change in commute behavior.

2.1. Built environment

Relocation often implies significant changes of the built environment characteristics experienced by commuters; this creates new opportunities or imposes constraints and might induce residents to alter their modal choice after relocation (Næss, 2005; Aditjandra et al., 2016). In the Chinese context, suburban areas are not well connected by public transportation and offer much less opportunities for active transport modes. It is well known that facilities for active transport provided in a new neighborhood are positively associated with walking and cycling (Giles-Corti et al., 2013). This finding is congruent with a more general literature that people living in neighborhoods with better walking or cycling facilities such as cycle routes, sidewalks and secure cycle parking are more inclined to use active transport (Pucher et al., 2010; Susilo et al., 2012). By contrast, Winters et al. (2010) found that built environments with high arterial accessibility stimulate people to substitute active travel for car travel. Other studies have emphasized the role of changes in public transport quality. Lo et al. (2011) and Scheiner and Holz-Rau (2013b) found that the provision of effective public transit services in a new neighborhood is positively associated with the use of public transit. Similarly, Cervero and Day (2008) and Aditjandra et al. (2016) concluded that short walking distances to bus stops, metro stations or subways are more likely to attract more travelers.

However, there is also conflicting evidence. For example, Ma et al. (2014) and Feng (2016) found that physical neighborhood form and a well-supplied cycling environment have very limited effect on active travel. These findings are consistent with an abundant literature suggesting that urban form is at best a modest contributor to travel behavior (Maat and Timmermans, 2009; De Vos et al., 2012). Upon reflection, beyond the questionable methodological underpinnings of particularly much early work on the influence of built environment on activity-travel behavior, several considerations may explain these apparent contradictions. First, it should be realized that the overall distance or travel time between home and work might prohibit the use of active transport modes. Particularly, in the context of residential relocation, this may be a primary reason because typically distances tend to increase after relocation to suburban areas. Second, people show a tendency to maximize the overall utility of their daily activity travel patterns (Rasouli and Timmermans, 2014). Unless their local neighborhood provides at least the same facilities of the same quality as competing destinations, which is rarely the case, people tend to visit other neighborhoods and use modes other than walking and cycling. Only if people cannot act on their preferences due to budget or spatial-temporal constraints, the built environment may exert a strong influence on activity-travel choices.

Recent studies have emphasized the importance of perception in quasi-longitudinal comparisons to better interpret the contribution of the built environment on travel decisions (Ewing and Handy, 2009; Panter et al., 2014). Using multivariate regression analysis, Panter et al. (2014) assessed how perceived and cognitive changes in the built environment impact travel mode choice and concluded that improved perception of public transport convenience or cycling safety may help promote active commuting. The formation of cognitions takes time and therefore behavioral change tends to involve a time lag after physical change. Goodman et al. (2014) argued that new high-quality routes for walking or cycling provided in a neighborhood only exert some influence on active travel after two years.

2.2. Individual and household characteristics

Apart from the built environment, socio-demographic characteristics influence travel behavior (e.g., Ewing and Cervero, 2010; Akar et al., 2013), reflecting that people with different socio-demographic profile have a certain tendency to have different needs and face different constraints. Studies addressing the relationships between land use and travel behavior demonstrated that besides residential density, sociodemographic characteristics including income, car ownership, and household composition played a significant role in affecting car use (Cao et al., 2009; Hickman et al., 2010; Milakis, 2011). Maat and Timmermans (2009) found that single workers are more likely to use a car. Having a child also stimulates car use for commuting trips because people often combine the work commute with escorting children to school (Tyrinopoulos and Antoniou, 2013). Using longitudinal data, race and household composition were significant predictors of post-move walking (Wells and Yang, 2008). Christiansen et al. (2014) concluded that besides living in high walkable neighborhood, holding a tertiary education and being part of a young adult group were associated with higher odds ratios

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