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Travel mode choices in small cities of China: A case study of Changting

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ABSTRACT

The existing literature on urban transportation planning in China focuses primarily on large cities and neglects small cities. This paper aims to fill part of the knowledge gap by examining travel mode choice in Changting, a small city that has been experiencing fast spatial expansion and growing transportation problems. Using survey data collected from 1470 respondents on weekdays and weekends, the study investigates the relationship between mode choice and individuals' socio-economic characteristics, trip characteristics, attitudes, and home and workplace built environments. While more than 35 percent of survey respondents are car owners, walk, bicycle, e-bike, and motorcycle still account for over 85 percent of trips made during peak hours. E-bike and motorcycle are the dominant means of travel on weekdays, but many people shift to walking and cycling on weekends, making non-motorized and semi-motorized travel especially important for non-commuting trips. Results of multinomial logistic regression show that: (1) job-housing balance might exert different effects on mode choice in different types of urban areas; (2) negative attitude towards e-bike and motorcycle is associated with more walking and cycling; and (3) land use diversity of workplace is related to commuting mode choice on weekdays, while land use diversities of both residential and activity places do not significantly affect mode choice on weekends. Our findings imply that planning and design for small cities needs to differentiate land use and transportation strategies in various types of areas, and to launch outreach programs to shift people's mode choice from motorized travel to walking and cycling.

1. Introduction

Travel behaviors have been widely investigated in large metropolises of China (Wang and Chai, 2009; Zhao et al., 2014), but have been mostly overlooked in the hundreds of small cities. According to the *Annual Report on the Development of Small and Medium-Sized Cities in China 2015*, cities with a population less than 500,000 are classified as small cities (CDRI, 2015). In the recent decades, most small cities in China have witnessed intensified infill development in central areas and rapid urban expansion at the periphery. The central areas of these cities are typically characterized by relatively high population density, concentrated amenities, mixed land uses, and diversified activities, while the suburbs have smaller populations and are often developed as predominantly single land use areas such as industrial zones or residential zones. Fast paced urban development in small cities also leads to accelerated motorization and severe traffic congestions, which have been commonly observed in large cities (Pan et al., 2009; Ye et al., 2013). In 2012, the Chinese government began to implement the "new urbanization" strategy that encourages the in-situ urbanization (*ben di cheng zhen*

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hua) and economic development of small cities (Wang and Wang, 2015). This national policy will not only promote further growth of small cities, but also stimulate the demand for motorized travel in these cities. China's urban planners need to develop effective land use and transportation strategies to maintain the traditional "green transportation" (e.g. walking, cycling, and bus riding) in small cities by encouraging the choice of non-motorized travel modes.

The contextual factors of China's small cities, such as economic development, urban form, infrastructure construction, and household socio-economic characteristics are different from those in large cities. Consequently, travel behaviors of residents in small cities are different from what we have learned in large cities. For instance, in response to the challenge of reducing traffic congestion, air pollution, and greenhouse gas emission, China's large cities have intensely promoted public transportation by constructing rail transit systems, adding new bus lines, and improving service. The mode share for public transportation remains quite high in cities such as Shanghai where bus and rail transit serve almost one third of trips in the central area (Shen et al., 2016). In contrast, public transportation shows a low modal split (less than 10 percent) in most small cities of China due to limited transit networks, poor service characterized by frequent delays in departure and arrival, and small fleets of buses (Wan et al., 2013).

In general, we know relatively little about transportation problems in small cities. The existing knowledge of travel behaviors and their underlying causes in these cities is inadequate for guiding the practice of urban planning and policy making.

This paper aims to answer two research questions: (1) what are the key characteristics of residents' travel behaviors in small cities of China? and (2) what factors and to what extent these factors influence residents' travel mode choices in these cities? We approached these questions through a case study of Changting, which is located in Fujian Province. Using data collected through a travel survey, we estimated multinomial logistic regression models to investigate the effects of built environment and attitudinal factors on mode choice while controlling for individuals' socio-economic and trip characteristics. The next section briefly reviews previous research on travel mode choice and highlights urban transportation challenges facing small cities in China, followed by a description of the study area, data collection, and modeling approach in the third section. Then, descriptive statistics are presented and results of the regression models are interpreted. Our research findings allow several important conclusions to be drawn in the last section of the paper.

2. Literature review

2.1. Factors affecting travel mode choice

2.1.1. Built environment factors

Although there is no consensus about factors affecting travel mode choice, many studies have found that built environment characteristics including density, land use mix, and street design influence people's mode choice (Cervero, 2002; Handy et al., 2005; Senbil et al., 2009; Bergman et al., 2011; Haybatollahi et al., 2015; Shen et al., 2016). To be specific, high density and mixed land use are shown to make people prefer non-motorized travel modes. Some examine the impacts of built environment at both trip origin and destination, and find that workplace environment creates greater effects on mode choice than residential environment (Chen et al., 2008; Kwoka et al., 2015). In addition, a dense public transportation network helps to keep users, while a less developed public transportation system can cause transit riders to switch to cars (Susilo and Maat, 2007). Local topography like hilly roads in mountain cities help make motorcycle a popular mode choice (Weinert et al., 2008).

Studies conducted in Chinese cities find similar relationships between built environment characteristics and mode choice (e.g. Ye et al., 2014; Tana et al., 2015). Compact and clustered developments with high job and population densities and balanced job-housing opportunities are shown to help reduce automobile use and increase non-motorized travel (Wang and Zhou, 2016). Higher levels of mixed land use, transportation connectivity, and accessibility to commerce and jobs are also associated with lower shares for motorized personal travel modes (Zhang et al., 2013). Pan et al. (2009) choose four neighborhoods from inner and outer-city areas of Shanghai to study the impact of neighborhood types on mode choice, and find that pedestrian/cyclist-friendly urban form can help lower the level of motor vehicle ownership. Naess (2010) presents findings from Hangzhou indicating that living close to the primary center of the metropolitan area is associated with higher proportions of trips by bicycle and on foot than living close to sub-centers. A recent study focusing on aggregated travel behavior in 161 Chinese cities identify positive effects of city size, but negative effects of density, on car ownership and usage (Sun et al., 2015). However, relatively few studies actually evaluate the magnitude of the impacts of statistically significant factors.

2.1.2. Socio-economic factors

Prior studies show that socio-economic indicators of households and individuals strongly influence people's mode choice (Cervero, 2002; Van Acker and Witlox, 2010). For instance, men tend to drive more frequently than women (Giuliano, 1983). In the Chinese context, higher income, higher job status, and car ownership are associated with greater probabilities of car use, while female and older people prefer walking or cycling (Pan et al., 2009; Shen et al., 2016). The existing literature indicates that income, gender, age, and car ownership are the most frequently examined variables in the mode choice analysis.

2.1.3. Attitudinal factors

In addition to observable socio-economic and built environmental characteristics, less tangible factors such as attitudes, motives, and preferences affect travel mode choice as well (Ben-Akiva et al., 1999; Collins and Chambers, 2005; Elias and Shiftan, 2012). Individuals in similar situations and with comparable socio-economic characteristics often make different mode choices because of various attitudes toward traveling (Li et al., 2013; Haybatollahi et al., 2015). The enthusiasm for driving cars or the pursuit of privacy