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The impact of urban characteristics and residents' income on commuting in China

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ABSTRACT

This study examined the relationship between urban characteristics and residents' commuting behaviour using sample survey data from 106 cities in China. We found that the average commuting time of high-income groups is significantly longer than that of low-income groups. The increasing urbanization rate leads to an increase in commuting time and more residents using public transport for commuting. The increase in the urban population density is expected to increase the commuting time and the possibility of commuting using non-motorised modes. Different urban characteristics have different effects on the commuting patterns of residents within different income groups. The increased urbanization rate promotes the use of motorised modes for commuting in the high-income group, and shortens the commuting time of the low-income group. We also found that population density and neighbourhood-level factors have a greater impact on the commuting time of the low-income group compared to the high-income group. We suggest China's urban planners should place emphasis on the commuting requirements of the low-income group by China's urban planners.

1. Introduction

With rapid urbanization and increased motorisation, cities are constantly expanding, and this is accompanied by a gradual change in the urban built environment in China (Pucher et al., 2007; Sun et al., 2014). In recent years, the large-scale cities in China have experienced rapid expansion. The increase in household income has led to an increase in private car ownership, and residents are increasingly dependent on commuting by private car. For instance, in Shanghai, a megacity in China, the urban area has increased from 550 km^2 to 886 km^2, with the population density increasing from 2205 to 2635 persons per square km, and private car ownership increasing from 50,400 vehicles to 1,411,600 vehicles between 2000 and 2012 (Sun et al., 2017). According to statistics, national car ownership reached 194 million in China, and there were 49 cities with more than one million cars in 2016 (China Traffic Management Bureau, 2016). Some research reports show that the annual loss caused by traffic congestion accounts for 5–8% of China's gross domestic product (GDP) (Shanghai Municipal People's Government, 2011). Moreover, approximately 50% of the total nitrogen dioxide (NO_2) emissions come from road traffic (Frey et al., 2010; Shon et al., 2011). Therefore, traffic congestion and air pollution caused by city expansion and motorisation have become urgent problems for the sustainable development of large cities in China.

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Existing studies have shown that the characteristics of a city have a significant impact on commuting (e.g. the population density and job-housing balance) (Sun et al., 2017; Cao, 2017; Renne et al., 2016; Sun and Dan, 2015). For instance, using the data from 4400 fixed guide way transit stations across the United States and a multiple-level model, Renne et al. (2016) found that neighbourhood-level variables (population, job intensity, etc.) and the regional network accessibility variable are significant variables in predicting the mode share for transit commuting. Using a survey conducted in Beijing, Zhao (2014) found that residential density has no significant effects on the use of a bicycle for commuting, and higher levels of public transit services decrease bicycle commuting. Sun et al. (2017) found that the proportion of four-way intersections, road density, and population density in residential areas are negatively associated with the driving probability in Shanghai. In terms of the relationship between job-housing balance and commuting, many studies proved that the job-housing balance influenced individual commuting behaviour (Horner et al., 2015; Zhou and Long, 2014; Zhao et al., 2011; Zhou and Long, 2014). For example, based on 2008 Xi'an city-wide household travel survey data, (Zhou and Long, 2014) the jobs-housing balance has larger impacts on bus commutes than on car commutes. Lin et al. (2016) used survey data from Beijing and found that the job-housing balance has a more significant impact on workers' commuting time than their socio-economic characteristics. However, few studies on the differences between commuter time and commuting modes in different types of cities in China have been published. Especially in the context of China's rapid urbanization, there is a huge difference in the level of development of transportation between different types of cities. What are the effects of the urbanization process on residents' commuting behaviour in China?

Income is an important factor related to commuting behaviour. Some previous studies have found that there is a positive correlation between income and commuting time (Manaugh et al., 2010; Sermons and Koppelman, 2001). For example, Manaugh et al. (2010) carried out a study in the Montreal metropolitan area and found that the commuting time of residents with a lower income is shorter than for residents with a higher income. However, this conclusion may be not applicable in China. For example, Zhao et al. (2011) found that the commuting time of the low-income group is significantly longer than that of the high-income group in Beijing, China. He also put forward that the commuting burden for China's low-income group could be understood by the new social-spatial structure in China's cities (Zhao, 2015). Most previous studies on commuting of different income groups in China mainly used survey data based on a single city, especially large cities. What is still missing in the literature is the link between residents' commuting behaviour and the characteristics of cities. What are the differences in the commuting behaviour of different income groups in different types of cities in China? The present study manages to answer these questions by incorporating the analysis of residents' commute modes within a multilevel framework.

To fill in these knowledge gaps, this study investigates the factors that influence residents' commuting behaviour in China. We use multilevel models to determine the factors that significantly influence the commuting time and traffic modes based on questionnaire data collected in 124 cities in China (106 valid sample cities in this study). The remainder of this paper is organised as follows. Section 2 describes the data and methods. Section 3 presents the results of both a descriptive analysis and multilevel models on residents' commuting. Section 4 discusses the results and policy implications, and Section 5 summarises the main findings of this paper.

2. Methods

2.1. Data

The data used for this research were obtained from the 2014 China Labour-force Dynamics Survey (CLDS 2014) conducted by the Centre for Social Science Survey of Sun Yat-sen University, China. The CLDS was a nationwide cross-sectional survey, covering 29 mainland provinces and municipalities (excluding Tibet and Hainan), with a multistage cluster, and stratified probability sampling strategy. The CLDS established a tracking database on three levels: individual, neighbourhood, and prefecture-level cities. We used a multilevel mixed-effects generalized linear model on the relationship between the commuting time and city/neighbourhood characteristics, and used multilevel mixed-effects logistic regression on the relationship between traffic modes and city/neighbourhood characteristics in this study. After excluding the missing data, 10,383 individual samples and 106 city samples were included in our regression analysis.

2.2. Dependent variables and independent variables

There are three dependent variables in this study, commuting time, commuting mode 1, and commuting mode 2. The commuting time refers to the total time respondents spend commuting on a daily basis. Commuting mode 1 includes commuting using motorised and non-motorised modes. Motorised modes include motorcycles, the bus, the metro, taxis, and private cars. Non-motorised modes include walking and cycling. Commuting mode 2 includes both private and public transport modes. Private transport modes include private cars, bicycles, motorcycles, and walking, while public transport modes include the bus, metro, and taxi. The independent variables include prefecture-level city variables and neighbourhood-level variables. The prefecture-level city variables include the urbanization rate, population density, the number of public transportation vehicles per 10,000 persons in the city, and the per capita area of paved roads in the city. The neighbourhood-level variables include the neighbourhood population density and the number of the enterprises in the neighbourhood. A series of controlled variables are included in the regression models: age, gender, marital status, education attainments, annual personal income and the length of residence in the city. Furthermore, to find out the different impact of prefecture-level city variables and neighbourhood-level variables on the commuting time and traffic modes of the low-