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Exploring car ownership and car use in neighborhoods near metro stations in Beijing: Does the neighborhood built environment matter?

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ABSTRACT

Public transport services are believed to play an important role in constraining car use. However, it has been found that cars are still used at high rates near many metro stations. This paper aims to explore car ownership and car use in people living close to metro stations. Taking Beijing, China, as a case study, this study shows that the likelihood of owning a car, and the number of work and non-work vehicle kilometers traveled (VKT), is lower in areas with higher mixed land use. Residents' income and family structure both affect VKT. People with an awareness of sustainable land use and transportation modes use fewer VKT. The study also has some interesting new findings in the Chinese context. It found that residential density was not significantly related to VKT. Interestingly, neighborhood type was firmly associated with car ownership and use: those who live in *Danwei* neighborhoods generated more work VKT, and those living in indemnificatory neighborhoods used more non-work VKT. Additionally, renters were less likely to own cars than house owners, and people with Beijing *hukou* generated more VKT. People preferring to live in close proximity to the metro system and travel by foot were more likely to own cars in the future than other people. The results suggest that increasing land use diversity and the accessibility of living amenities in neighborhoods near metro stations could enhance the performance of transport systems by reducing dependence on cars. Housing and transport policies, along with behavior-education programs, could strengthen this effect.

1. Introduction

Car dependence is an important contributor to air pollution, traffic congestion, and obesity prevalence in Western countries (Handy et al., 2005; Banister, 2000; Næss, 2006). Therefore, the determinants of car ownership and car travel are important themes in transportation research (Schwanen et al., 2004; Susilo and Maat, 2007; Scheiner and Holz-Rau, 2007; Buehler et al., 2017; Aditjandra et al., 2016). It is widely believed that improving public transport services would play an important role in constraining car use (Dittmar and Ohland, 2012; Potoglou and Kanaroglou, 2008; Gossen, 2005). Therefore, in many countries, expensive projects have been implemented to improve the quality of public transport services. Despite this, it has been found that car use is still at a high level in many areas near transit stations (Chatman, 2013; Cervero and Murakami, 2010), indicating that there are other reasons determining car ownership and use in areas near transit stations.

The new urbanists believe that neo-traditional neighborhood design, characterized by high residential density, mixed land use

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and grid-street patterns, can encourage walking-friendly environments and discourage people from owning and using cars. In this way, neo-traditional urban design contributes to improvements in air quality and alleviation of traffic congestion (Calthorpe, 1993). However, the effects of neighborhood design are still debatable. Some researchers question the impact of the built environment on car ownership and use, and have found that neo-traditional neighborhood design has only a limited role in constraining car use (Joh et al., 2008; Crane and Crepeau, 1998). Some researchers believe that people's socioeconomic attributes (Crane, 1996) and self-selection (Boarnet and Sarmiento, 1998) are more important than the built environment in determining car ownership and car travel.

China's cities have invested a huge amount in their public transport systems. To improve their management and effectiveness, Ministry of Transport (2014) has proposed a plan to create transit cities in China, thereby increasing public transport ridership, and reducing air pollution and traffic congestion (Ministry of Transport, 2014). Many cities in China offer a rapid and sustainable public transport system, such as the metro and Bus Rapid Transit (BRT). China has witnessed an urban rail transit construction boom over the last decade, making it the world's largest urban rail transit construction market. By 2020, China's urban rail mileage will reach 7395 km (China Decision Makers Consultancy, 2014). Additionally, to mid-2013, a total of 17 cities had put a BRT system into use. As at the end of 2012, the length of BRT routes in China exceeded 500 km (Cervero, 2013). The central government also provides subsidies for fuel for buses as an economic incentive to extend the urban bus system. However, in recent years, financial policies have changed. Buses using oil as fuel now receive fewer financial subsidies year by year, as a way of encouraging more buses to replace oil with gas and electricity (Bao, 2015).

In recent decades, Chinese society has also undergone rapid growth in car ownership and car use. According to an official report, every 100 urban households in China has 30 private cars (National Bureau of Statistics, 2016). As at the end of 2015, there were more than 140 million private cars in China, a 137% increase from 2010 (National Bureau of Statistics, 2016). Moreover, Chinese residents use cars heavily in daily travel. For example, in 2010, the average travel distance of a private car in Beijing was more than 15,000 km per year, 1.5 times more than cars in Paris and twice those in Tokyo (Tu, 2011). The large number of cars and the heavy reliance on them bring many serious problems, such as increased energy consumption, air pollution, and traffic congestion. According to Wang et al. (2011b), the growth rate in fossil fuel demand for the transport sector has reached 10.56% per year. The rapid growth of private car ownership is an important factor contributing to fuel demand. The overdependence of private cars on fossil fuels has caused serious air pollution. According to another report (Ministry of Environment Protection, 2016), cars have become the main source of air pollution in China and a major cause of photochemical smog pollution. Moreover, traffic congestion is a byproduct of the car boom in China. According to a recent report, many large and medium cities in China – such as Beijing, Guangzhou, Hangzhou, and Jinan – are experiencing serious traffic congestion. Taking Jinan as an example, travel time by car during peak hours can be 2.1 times longer than during non-peak hours (Gaode Map, 2016).

There are many factors influencing rates of car ownership and car use in China's cities (Huang et al., 2012; Wan et al., 2009; Deng, 2007). Changes in the built environment could be an important one (Zhao, 2011, 2013; Feng et al., 2011; Wang and Zhou, 2017). Although many studies have provided evidence of the impact of the built environment on car ownership and car use, there are still several major research gaps to be filled. Firstly, previous studies exploring the impact of the neighborhood built environment on car ownership and car use rarely take into account the proximity of metro lines and regional accessibility, which may lead to misunderstandings about the role of the neighborhood built environment (Huang et al., 2017). Secondly, most of the studies have been conducted in car-dependent countries. These studies may have few policy implications for dense and compact cities like those in China. More importantly, studies rarely integrate the impact of neighborhood type, metro proximity and neighborhood built environment. *Neighborhood type*, typically classified by the source of the houses, is an important predictor of travel behavior variability in contemporary China (Wang and Zhou, 2017). However, few studies have been conducted that explore the role of neighborhood types on car ownership and use, nor do these studies consider the role of metro proximity. Finally, existing studies rarely take into account the intentions of people without cars in purchasing one. Unlike in developed countries, private car ownership and use are still increasing rapidly in developing countries (Zhao, 2014). Yet studies considering the motivations for car purchase remain rare.

This paper aims to fill the above research gaps by exploring the impact of the built environment on car ownership and car use among residents living in fifteen neighborhoods near metro stations in Beijing. The paper is organized as follows: Section 2 is a literature review of the determinants of car ownership and car use; Section 3 describes the data, the variables, and the method; Section 4 demonstrates the regression results; Section 5 discusses the key findings and policy implications; and Section 6 gives the conclusions of the paper.

2. Literature review

According to Ewing and Cervero (2010), characteristics of the built environment include residential density, land-use mix, urban design, destination accessibility, distance to transit stations, and parking provision. These are widely accepted as the "six Ds". Existing studies exploring the impact of the built environment on car ownership and car use mainly focus on the built environment at the neighborhood level. Whether planners can decrease car ownership and usage rates through local built environment planning is debatable (Ewing and Cervero, 2010). Positivists believe that increasing neighborhood residential density and land-use mix are efficient ways to reduce traffic congestion and air pollution (Boarnet and Sarmiento, 1998). Negativists doubt whether the local built environment (characterized by high residential density, mixed land use, and grid-street patterns) can help reduce car ownership and use. The argument is that these characteristics improve destination accessibility, making car travel faster and less costly and, hence, more popular. For this reason, the total travel distances of cars may increase rather than decrease (Kulash et al., 1990; Crane, 1996).