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Factors affecting car ownership and mode choice in rail transit-supported suburbs of a large Chinese city

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ABSTRACT

As Chinese cities continue to grow rapidly and their newly developed suburbs continue to accommodate most of the enormous population increase, rail transit is seen as the key to counter automobile dependence. This paper examines the effects of rail transit-supported urban expansion using travel survey data collected from residents in four Shanghai suburban neighborhoods, including three located near metro stations. Estimated binary logit model of car ownership and nested logit model of commuting mode choice reveal that: (1) proximity to metro stations has a significant positive association with the choice of rail transit as primary commuting mode, but its association with car ownership is insignificant; (2) income, job status, and transportation subsidy are all positively associated with the probabilities of owning car and driving it to work; (3) higher population density in work location relates positively to the likelihood of commuting by the metro, but does not show a significant relationship with car ownership; (4) longer commuting distance is strongly associated with higher probabilities of riding the metro, rather than driving, to work; (5) considerations of money, time, comfort, and safety appear to exert measurable influences on car ownership and mode choice in the expected directions, and the intention to ride the metro for commuting is reflected in its actual use as primary mode for journey to work. These results strongly suggest that rail transit-supported urban expansion can produce important positive outcomes, and that this strategic approach can be effectively facilitated by transportation policies and land use plans, as well as complemented by timely provision of high quality rail transit service to suburban residents.

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1. Introduction

China's urbanization is continuing at a fast pace: between 2015 and 2030 its urban population is expected to increase by 230 million (China News, 2015; EastDay.com, 2015). One major challenge that Chinese cities have been facing for the last two decades, and will continue to face in the foreseeable future, is to provide satisfactory transportation that supports fast-paced urban growth and suburbanization, while striving to reduce traffic congestion, air pollution, and greenhouse gas emission. In response to the challenge, the large cities have uniformly adopted the strategy of constructing an extensive rail transit system to help meet growing travel demand and lessen automobile dependence. More than twenty cities now have a metro system in operation, and several dozens more cities are currently constructing, planning, or proposing such a system (Luan et al., 2014).

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Building a rail transit system to support urban growth is not a novel idea. Starting with London in 1863, many cities in the world have built metro systems and other forms of rail transit. Nonetheless, rail transit remains a highly controversial subject, as scholars disagree on whether it is an efficient system to satisfy urban residents' demand for mobility or to help cities achieve transportation-related environmental and social objectives (Baum-Snow and Kahn, 2005; Kain and Liu, 1999; Lave, 1998; Litman, 2007; Nelson et al., 2007; Voith, 2005; Winston and Maheshri, 2007; Zaretsky, 1994). Theoretically, the economic performance of a rail transit system depends critically on traffic volume and residential density (Meyer et al., 1965; Small and Verhoef, 2007). The great importance of these contextual factors suggests that empirical examination is often required to understand whether rail transit works well in a particular setting.

Gaining an understanding of the effects of rail transit development in China is imperative, because many cities—in China, as well as in other developing countries—are following this strategy without sufficient knowledge about the outcomes. This paper utilizes travel survey data from Shanghai to gain insights into how residents in rail transit-supported suburbs make choices regarding car purchase and, more importantly, transportation mode. The research focuses on suburban locations because the anticipated population growth in Chinese cities will mostly be accommodated in such locations. Here we generally define “rail transit-supported urban expansion” as urban growth that takes place in locations beyond the existing central city and that draws upon accessibility provided by rail transit, typically a metro system. To successfully facilitate sustainable development, rail transit-supported urban expansion must be a viable alternative to automobile-dependent urban expansion.

This paper presents an empirical study of the effects of rail transit-supported urban expansion in China, based on data for Shanghai. The research aims to answer three questions. First, what are the car ownership and modal choice characteristics of residents living in suburban areas near metro stations? Second, what factors are associated with suburban residents' car ownership status? Third, what factors are associated with suburban residents' commute mode choice? In addition to proximity to metro stations, socio-economic variables, built environment features, and attitudinal factors are considered in this analysis.

2. Literature review

Several bodies of literature are highly relevant to this research, and selected publications in each are reviewed here. One body of literature is on urban growth, suburbanization, and transportation challenges for cities in China. Another, drawn primarily from contributions by American and European researchers, presents competing perspectives on rail transit development as a response to urban transportation problems. A third strand of literature examines factors influencing people's car ownership decision and travel mode choice.

2.1. Urban growth, suburbanization, and transportation challenges for Chinese cities

China's urban population has been growing at an extraordinarily pace for the past three decades. In 1990 only less than 27 percent of its population lived in cities and towns, but in 2013 almost 54 percent resided in cities and towns. This doubling of urbanization level represents an additional urban population of over 400 million!

The rapid growth of urban population in China has been accompanied by continuous spatial transformation of cities. The built areas have greatly expanded, typically more than tripled since 1990. In the large cities, population growth has taken place primarily in newly developed suburban areas, accelerating the suburbanization process that started in the 1980s (Zhou and Meng, 1998).

The fast-paced urban growth and suburbanization have presented major challenges to urban transportation planners and policymakers. The rapidly increasing population, together with steadily increasing trip distances, has resulted in an ever rising travel demand that often overstrains existing transportation infrastructure and aggravates traffic congestion. Moreover, the urban spatial transformation has made automobiles an increasingly attractive, or necessary, mode of travel. In 1990 few Chinese households owned automobiles, but rapid income growth in China enabled motorization to quickly pick up pace (Gakenheimer, 1995; Shen, 1997). Less than twenty years later, in 2009, China became the world's largest automobile market. The most recent official statistics indicate that the number of passenger cars in the country has already passed 100 million, more than 50 times the number for 1990 (China Bureau of Statistics, 2014).

The combination of urban expansion and motorization will lead to automobile dependence unless some viable transportation alternatives become available to suburban residents. As a counter-measure to motorization and as a response to various transportation-related environmental and social issues, since the early 2000s the Chinese government has been emphasizing the importance of public transportation. Accordingly, large cities have gradually shifted their investment priority from highways and roads to rail transit. Facing serious challenges in providing mobility and in reducing emissions, planners and policymakers in China see rail transit as the key to solving transportation problems.

There are good reasons for being optimistic about what a rail transit system can bring to a city. A metro system can moderate accessibility loss resulting from relocation from central city to outlying areas and encourage many suburban residents to travel by rail instead of automobile (Cervero and Day, 2008). It also provides an opportunity for creating a multinuclei form of compact development with high-density suburban clusters around metro stations (Yang et al., 2012). Such a clustered spatial pattern of urban growth and suburbanization can help avoid, on the one hand, aggravated traffic congestion

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