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Changing travel behaviour in urban China: Evidence from Nanjing 2008–2011

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ABSTRACT

The unprecedented pace and scale of economic, social and spatial transformations in urban China have by now been well documented. But while it is highly likely that these changes relate to far-reaching alterations in travel behaviour as well, so far this topic has received much less attention. With this paper, we aim to help fill this gap through the following research questions: *What are the main changes in travel behaviour in Nanjing, China; and how can we explain these changes?* We answer these questions on the basis of a study of repeated cross-sectional data from the Nanjing Residents Travel Survey (NRTS) of 2008 and 2011. This leads to three main conclusions: first, changes in the urban form and transport systems of Chinese cities lead to larger daily travel distances and a considerable increase of transport by private cars and public transport at the expense of non-motorised transport modes; second, the impacts of the built environment and socio-demographics as determinants for travel behaviour change in different ways over time; and third, changes are not the same for all groups as there is a widening gap in travel behaviour of low-income groups and middle and high-income groups. We discuss the consequences for social exclusion and environmental sustainability.

1. Introduction

Over the last decades, the pace and scale of economic, social and spatial changes in urban China has been unprecedented (Friedmann, 2005; Ma and Wu, 2005; Logan, 2011). With more than 8% GDP rise per year on average, fast economic growth has resulted in individual affluence for many, and the average urban incomes tripled in the last five years (CSB, 2000–2011). With rising incomes, car ownership of urban residents rapidly grew as well from 3.4% to 18.6% between 2005 and 2011 (CSB, 2012). Experiences in the West suggest that these increases in income and car ownership will also result in substantial changes in travel behaviour (Giuliano and Narayan, 2003; Susilo and Maat, 2007).

Economic growth relates to social changes. For travel behaviour, two developments are especially relevant. Firstly, a substantial part of the population has not benefited from economic growth, resulting in dramatic social polarisation (Wang, 2004; Ma and Wu, 2005) which might influence the travel choices of different social groups. Second is the 'rise of the individual and the consequential individualisation of society' in China (Yan, 2010) in which differentiated lifestyles and diversified consumer (and, more specifically, travel) behaviour are observed (Inglehart and Baker, 2000). Moreover, the 'classical' socio-demographics such as gender, age and employment might give way to subjective attitudes, values and pursuit of personal interests in determining individuals' travel behaviour in an individualised society (Scheiner, 2010).

Spatial transformations include urbanisation and a related expansion of cities. The built up area of Nanjing, for example, grew by 85 km^2 between 2005 and 2009 (NSB, 2006–2011). Fast motorisation fuels this suburbanisation, and growing numbers of affluent car-drivers now live in the suburbs (Feng and Zhou, 2005). Growing affluence also creates new activity opportunities, resulting in large-scale shopping malls as well as specialised shopping, eating and entertainment districts (Wang and Jones, 2002). These developments dramatically increase travel demand (Shen, 1997; Ng et al., 2010). The whole country thus embarked on massive highway construction programs, with an estimated 53,000 km of expressways built since 2007 alone, compared to an overall length of 75,000 km in the United States (United States Central Intelligence Agency, 2010). Cities also undertake significant investments in subways, light rail and rapid bus transport. From 2009 to 2015, 25 cities for instance plan to construct 87 mass transit rail

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lines, totalling 2495 km (Business Sohu, 2010). It seems likely that these changes in built environment and transport supply again will have huge consequences for travel behaviour.

In view of these developments, it seems safe to assume travel behaviour in urban China is undergoing significant changes. We expect that travel distances will grow considerably, and that the use of cars and public transport use will increase dramatically at the expense of non-motorised modes of transport. Moreover, the economic, social and spatial changes might have different impacts on different population segments that some of the disadvantage groups might face the risk of social exclusion. In other words, changes in built environment and travel behaviour potentially have undesirable consequences like social and environmental unsustainability. Is the above happening or already happened in urban China? What we should do to minimise the negative impacts of these changes?

An analysis of these developments necessitates research at different times. Research into travel behaviour in urban China to date in general is still in its infancy (for instance, see Feng et al., 2013a, 2013b). To the best of our knowledge, this body of work does not yet include comparative studies based on repeated cross-sectional data. Therefore, we aim to help fill this knowledge gap with a study of changing travel behaviour in Nanjing, China. Specifically, we will answer the following research questions: *What are the main changes in travel behaviour in Nanjing, China; and how can we explain these changes?*

We answer these research questions through an analysis of data from the cross-sectional Nanjing Residents Travel Survey (NRTS), which was undertaken in 2008 and 2011. We will trace the trends in mode choice, daily travel distance and daily travel time, and we will examine the impacts of socio-demographic characteristics as well as built environment characteristics. This analysis will start with a review of the relevant literature on the dynamic linkage between built environment and transport in section two. The third section presents an overview of our data and methods. Section four follows with a descriptive analysis of our data, and section five discusses the regression analyses for mode choices and travel distances. The sixth section concludes the paper with answers to the research questions and a discussion of the results.

2. Urban form and the transport system – the literature

Drawing on the data from industrialised countries, various studies show that changes in the socio-demographic and spatial structures of metropolitan areas have a profound influence on travel patterns (Susilo and Maat, 2007; Schwanen et al., 2001; Zhang, 2004). Without exception, studies report that travel distances increase dramatically as a combined effect of increasing affluence, increasing car ownership, and fast urban expansion and suburbanisation (Levinson and Kumar, 1994; Susilo and Kitamura, 2008; Feng et al., 2013b). Susilo and Maat (2007) find that from1993 to 2005 total daily travel distance and commuting distance in the Netherlands increased by 7.5% and 23%, respectively. Furthermore, socio-economic and spatial developments also go together with changes in mode choices, with an increase of private car use, and a decrease of the use of public transport, cycling and walking (Schwanen et al., 2001; Zhang, 2004; Susilo and Maat, 2007). At the same time, however, mean travel times remain remarkably stable (Zahavi and Ryan, 1980). This phenomenon, known as the 'travel time budget', has received a law-like status in the transport literature. However, it does not go unchallenged, and a comprehensive study of overall travel time budgets by Mokhtarian and Chen (2003) shows mixed results: in some cities, mean travel times are stable, but in other cities not.

There are also debates on commuting time. Levinson and Kumar (1994) observe that average commute times remained at 28 1/2 min in 1958, 1968, and 1988 in Washington, DC. They hypothesise a constant commuting time and attribute this to the mutually collocating of jobs and housing of individuals to optimise travel times. Kitamura et al. (2003) also find that commute trip duration remains constant – at about 36 min – in Osaka, Japan between 1980 and 2000. However recently, Levinson and Wu (2005) rejected their own theory of personal commuting budgets and argue that commuting duration tends to change not only over time at the intra-metropolitan area, but also with different spatial structures within different metropolitan areas. And Vandersmissen et al. (2003) show that commuting times increase significantly in Quebec, Canada between 1977 and 1996.

In the last few decades various studies with different geographical scales and locations have studied the influence of the built environment on transport (for instance, see Ewing et al., 2001; Zhang, 2004; Susilo and Maat, 2007). The spatial determinants of travel have been summarised as the 3Ds—density, diversity and design (Cervero and Kockelman, 1997)—and then are extended to the 6Ds—destination accessibility, distance to transit and demand management in addition to the 3Ds (Ewing and Cervero, 2010). Generally, it is found that inhabitants of dense, compact cities with mixed land use and high accessibility to public transportation and facilities are likely to travel shorter distance and use more non-motorised modes (Næss, 2012; Feng et al., 2013b). Recently, emerging attempts have been made to incorporate subjective influences, such as the perception of built environment, attitudes towards specific travel and life pattern, into land-use travel behaviour interaction models (Van Acker et al., 2013; Aditjandra, 2013; Aditjandra et al., 2013). For example, Aditjandra et al. (2013) found that residents in traditional neighbourhood group is more sensitive than those live in suburban neighbourhoods to actors of perception and attitudes in relation to neighbourhood design that lead to walking, cycling and public transport use travel patterns.

However, unfortunately there are only limited studies on the dynamic relationship between land use and transport *over time* at the disaggregate level. Susilo and Maat (2007) examine the influence of the built environment on commuting parameters in the Netherlands in 1995, 2000 and 2005. They find that the impact of built environment characteristics on commuting distance and mode choice has increased. Vandersmissen et al. (2003) compare the commuting times of Quebec residents in 1977 and 1996. They conclude that decentralisation and diversification result in a decreasing effect of the mixing of functions on commute times. To our knowledge, there is no literature examining the linkage between land use and travel in China over time. Existing research draws on data at a single point of time. Pan et al. (2009) for instance examine the impacts of urban form on travel behaviour of residents in four Shanghai neighbourhoods, finding that people in pedestrian- and cyclist-friendly neighbourhoods travel shorter distances. Wang et al. (2011) report that Beijing residents in newly developed residential areas in Beijing, like commodity housing estates and social welfare housing estates, tend to travel longer distances and times and use private cars more often than people living in traditional *danwei* compounds.

In addition to variables relating to the built environment, socio-demographic characteristics are also considered important determinants of travel behaviour (Schwanen et al., 2001; Susilo and Maat, 2007). Thus, various studies examine the impact of variables like gender, age, educational attainment, income, household car ownership, and household structure. Stead (2001) argues that these socio-demographic variables have a more pronounced influence on travel behaviour than built environment characteristics. However, others like Ohnmacht et al. (2009) and Scheiner (2010)