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Excess kindergarten travel in Changchun, Northeast China: A measure of residence-kindergarten spatial mismatch

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ABSTRACT

Home-kindergarten travel is an important urban travel activity. This paper firstly discussed the relationship between excess kindergarten travel and residence-kindergarten spatial mismatch. And then questionnaires and GIS are used to provide some baseline analyses of their distribution pattern both statistically and spatially in Changchun. Thirdly, we provide an exploratory analysis of the causes of excess kindergarten travel and spatial mismatch. Results indicate that a) kindergartens in Changchun are highly accessible if children attend their nearest kindergartens, b) however, there is numerous excess travel and high degree of spatial mismatch, nearly 87.1% of the kindergarteners travel excessively, c) the excess travel distances in inner city are much shorter than other areas, and the corresponding spatial mismatch degree is lower. Two critical factors influencing excess kindergarten travel and residence-kindergarten spatial mismatch are summarized. Firstly, the actual causes are a) parents' personal preferences and kindergarten choice tendencies, b) Danwei owned kindergartens generally with higher quality, tendentious enrollment policies, charge threshold, and c) the widespread use of private cars. Secondly, the root causes are limited public expenditure on kindergarten education and its unbalanced allocation, as well as Chinese traditional concept and prevailing way of parenting.

1. Introduction

In China, there is always heavy traffic during workday rush hour in most large cities. The main stream of traffic flow includes commute, home-school and home-kindergarten travel. However, when it comes to school and kindergarten vacations (i.e. two of the longest vacations, which are one month of winter and two months of summer vacation), the traffic becomes much more unobstructed. Thus it can be seen home-school and home-kindergarten travel (hereafter called school travel and kindergarten travel) account for a large proportion of total travel.

Kindergartners (excluding persons who teach at a kindergarten) in China are encouraged to attend their nearest kindergartens from their residence. However, lots of parents didn't send their children to the nearest kindergarten actively or passively, leading to a longer travel distance. That means their travels to or from kindergartens are usually excess or wasteful. Excess kindergarten travel here is referred to as the difference between the actual travel distance and the minimum possible travel distance of kindergartners' attending kindergartens. It is similar to the term "wasteful commuting" and "excess commuting".

Hamilton (1982) firstly raised the term "wasteful commuting". He measured the actual commute and minimum commute of a number of U.S. and Japanese cities by a modeling approach, and figured out their wasteful commuting which ranged from 70% to 87%. While Hamilton's conclusion was challenged by White (1988), who adopted a linear-programming approach a few years later. White demonstrated there was only 11% wasteful commuting which was much smaller than Hamilton's for a sample of U.S. metropolitan areas. Then Hamilton (1989) explored possible reasons of bias in his and White's estimates and distinction between commute time and distance for the discrepancy. Small and Song (1992) clearly demonstrated that the considerable discrepancy derived from different methodologies they adopted, and proposed a normatively neutral term called excess commuting (EC).

Since Hamilton (1982), this interesting topic has captured the attention of transportation geographers, urban planners, and other spatial researchers. Literature in this field mainly focuses on three issues according to Ma's review paper (Ma and Banister, 2006a). The first issue is the causes of EC. Factors such as multi-worker households (Kim, 1995; Buliung and Kanaroglou, 2002), tenancy status (Cropper and Gordon, 1991; Kim, 1995), uncertainty of job location (Crane, 1996; Ommeren, 1998), heterogeneous housing and job markets

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(Manning, 2003), different tax subsidy systems (Merriman et al., 1995), and moving costs of jobs or housing (Giuliano and Small, 1993; Levinson and David, 1998), have been considered as determinants causing EC. But in fact, the immediate cause of EC is the spatial mismatch between expectations of workers and employers. The second is methodological issues. There are mainly two approaches to the estimate of EC. One is based on an urban economic model (Hamilton, 1982), and the other is liner-programming (LP) approach which was firstly adopted for the estimate of EC by White (1988) and then was used widely in this field. Also, many researchers made efforts to make the LP more reliable for EC, such as effects of geographical boundaries (White, 1988; Small and Song, 1992; Merriman et al., 1995; Horner and Murray, 2002), effects of different travel cost measures (White, 1988; Hamilton, 1989; Small and Song, 1992; Giuliano and Small, 1993; Merriman et al., 1995) and effects of spatial structure (Frost et al., 1998; Chen, 2000; Ma and Banister, 2007). Recently, GIS was applied to the measure of EC. Boussauw et al. (2014) simulated a large scale of home-school trajectories, and calculated the observed and minimum home-school distances by a tool of Network Analyst in ArcGIS. The third issue is policy implications. Policies aimed at reducing EC mainly center on jobs-housing balance (Scott et al., 1997; Horner, 2002), but it has rarely been used to support real-world policy (Ma and Banister, 2006a).

Commutes usually indicate a concrete link between residences and workplaces. On one hand, a substantial amount of research has been carried out capturing job-housing balance via excess commuting (Horner, 2004; Ma and Banister, 2006b; Layman and Horner, 2010; Suzuki and Lee, 2012; Zhou et al., 2014; Horner et al., 2015), as well as the overall efficiency of commuting (Scott et al., 1997; Zhou et al., 2013; Zhou et al., 2014). However, different methods for measuring EC and job-housing balance may not wholly address each piece of the commuting puzzle (Layman and Horner, 2010). On the other hand, the methodology framework of excess commuting was used to detect the spatial mismatch. Horner and Mefford (2007) linked EC with job-housing balance and spatial mismatch, then investigated spatial mismatch of Atlanta using the range between minimum and maximum commute. Horner's work contributed greatly to studies of spatial mismatch and related issues.

Literature mentioned above only focuses on home-to-work commute. Non-work travel has not been discussed in the framework of EC until Horner's enlightening research work. Horner and O'Kelly (2007) examined the potential and limitations of extending the EC framework and its associated methods to the analysis of non-work travel, and argued that the most frequent, common and regular of non-work travel was the most appropriate for study in an EC sense, while school travel in the U.S. was not well-suited because students were assigned to schools based on school districts. Later, Fan et al. (2011) analyzed excess travel (including both work and non-work related travel) by proposing new measures of the required and excess distances of daily travel at the household level. Boussauw et al. (2014) assessed excess travel in non-professional trips of Flanders and examined its relationship with spatial structure and degree of urbanization. As far as we know, only these three papers paid attention to the topic of excess non-work travel, although non-work travel usually account for a much larger proportion of total travel than commuting trips. The reasons may lie in the discretionary nature (Horner and O'Kelly, 2007) or methodological problems of non-work travel (Boussauw et al., 2011).

The same as home-to-work commute, school travel and kindergarten travel are also the most frequent, common and regular urban trips. And a great deal of research paid attention to school travel, such as topics of travel mode and its relationship with health, safety, environmental impacts, traffic congestion and school choice. School choices which mainly include neighborhood and magnet school impact travel mode greatly (Wilson et al., 2007; Müller et al., 2008; Wilson et al., 2010). However, school travel has not been discussed in the framework of EC except Boussauw's similar indicator called "excess rate" (2014). Nonetheless, the causes of excess commute, school and kindergarten travel are essentially different. For example, everyone has discrepancies in his/her motivations for choosing a job, a school and a kindergarten. Consequently, it is necessary to do some researches on school or kindergarten excess travel.

Besides, in terms of school travel and kindergarten travel, each of these travelers has only one destination, and their destinations are stable during a period. Obviously, these characteristics are similar with that of home-to-work commuting. In many countries, like US and China, schools are typically associated with a "school district", which corresponds to a geographic area defining the residences served by a school. School districts are partly designed to result in efficient home-to-school transportation as planners typically seek to minimize excessively long bus routes, student walks to school, and parent car trip lengths (Horner and O'Kelly, 2007). Further, because residences are assigned to schools based on districting, the school travel is rarely excessive. However, there is no kindergarten district constraint in China at all. Here the term "kindergarten district" is parallel to "school district". Therefore, parents can choose almost any kindergarten they prefer, and the distance costs may not be their main concern. This will lead to excess kindergarten travel unavoidably. So kindergarten travel is well-suit to analysis of EC framework and should be focused. This paper aims to assess excess travel of kindergarteners by obtaining a large number of exact location of each child's residence and his/her kindergarten and residence-kindergarten spatial mismatch based on GIS (Geographic Information Systems) methods, and then explore the causes and its social implications in Changchun.

2. Study area, methodology and data preparation

2.1. Study area

Changchun is the provincial capital of Jilin in Northeast China. The study area in this paper is Changchun central urban area (Fig. 1), which is the contiguously urbanized area. Commonly referred to as Chengqu in Chinese, the area is similar to the term "central city" (in contrast to suburbia) in the west but perhaps a bit beyond to include some highly-urbanized inner suburbs. This area is selected because of our primary interest in examining the excess kindergarten travel and residence-kindergarten spatial mismatch in the urban area. It composed of five urban districts (Qu) such as Chaoyang, Nanguan, Kuancheng, Luyuan and Erdao. Hereafter the study area is simply referred to as Changchun (Wang et al., 2014). According to 2010 census data, it had a population about 3.25 million, and covers an area of 410 km^2. There are 385 kindergartens (Fig. 3(a)) in the study area totally.

2.2. Methodology

2.2.1. Measurement of excess kindergarten travel

Quantitatively, excess commuting is usually measured by a relative metric of excess rate, which is represented as a ratio of additional commute distance to actual commute distance. Also, the relative quantity of excess kindergarten travel can be defined as the same way. Besides, excess travel distances will be calculated through the difference between the actual travel distance and the minimum travel distance to measure the absolute quantity of excess kindergarten travel.

$$E_r = \frac{D_a - D_m}{D_a} \times 100\% \quad (1)$$

$$E_d = D_a - D_m \quad (2)$$

Where E_r is the excess kindergarten travel, E_d is excess travel distances, D_a is termed as the average actual travel distance, and D_m represents the average minimum travel distance.