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Incorporating job diversity preference into measuring job accessibility

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ABSTRACT

Diversity is a hot topic in geography and planning. Though a few studies have considered diversity in evaluating accessibility, diversity and the love of diversity have not been simultaneously included in one indicator. This study proposes a method to tackle this challenge, incorporating the constant-elasticity-of-substitution function, with a parameter on the preference for diversity (ρ), into the accessibility indicator of the two-step floating catchment area method (2SFCA). This new method (AC) is implemented to measure Beijing's job accessibility at the jiedao scale which is the basic administrative level in Chinese cities, and compared with the 2SFCA method (AG) and the 2SFCA method with an entropy component for job diversity (AE). All three indicators reveal a similar overall spatial pattern of job accessibility. However, measured by rank of accessibility score, there are some differences between them. Most jiedaos' ranks change when the AE method is used instead of the AG method, though most changes are within a small range. In contrast, when the AC method is used with the ρ-value close to 1, meaning that diversity is almost not valued at all, only a few jiedaos' ranks change. Sensitivity analysis indicates that the accessibility scores' absolute values with the AC method are highly sensitive to the ρ-value, but the overall spatial patterns seem not to be. However, with AC, a small decrease in ρ changes the jiedaos' ranks significantly. Overall, the results indicate that the AC method provides better understanding of accessibility for regions with different preferences on diversity of opportunities.

1. Introduction

Accessibility is a core concept in several disciplines. In the classic paper by Hansen (1959, p73), it was defined as “the opportunity which an individual or type of person at a given location possesses to take part in a particular activity or set of activities.” Many indicators have been developed to measure accessibility (Geurs & van Eck, 2003; Handy & Niemeier, 1997; Kwan, 1998; Páez, Scott, & Morency, 2012). Most indicators refer to, or are devised to measure one particular type of activity, such as job accessibility or health care accessibility (Bhat et al., 2000; Cascetta, Cartenì, & Montanino, 2016; Niemeier, 1997; Wang, 2012).

However, for the activities belong to a particular type, there are always some differences between these activities. Strictly speaking, purely homogeneous activities within one type do not exist in reality. Moreover, more types present more options and the freedom to choose, which will increase the attraction of location and affect the value of accessibility (Laird, Geurs, & Nash, 2009). While it has been suggested that diversity of activities should be measured in the accessibility indicator (Bertolini, le Clercq, and Kapoen, 2005), few prior studies have incorporated diversity into evaluating accessibility (Cheng & Bertolini, 2013), and “the love of variety in consumption” is still ignored (van Wee, 2016). In comparison, diversity has become a hot topic in other related fields. For example, it is among the core concepts of new economic geography (NEG), as higher diversity in commodity types means higher utility (Krugman, 1991).

Accessibility measures may be classified into infrastructure-based, location-based, person-based and utility-based (Geurs & Wee, 2004). Location-based accessibility is widely used in research and practice (Curtis & Scheurer, 2010). This study primarily attempts to devise a new indicator to measure location-based job accessibility that reflects job diversity and the love of diversity. The case of Beijing will be used to illustrate the proposed method. The remainder of this article is organized as follows. The second section provides a literature review. The third section then develops the modeling methodology. The fourth section presents the results. Finally, the last section discusses and

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summarizes the main findings.

2. Literature review

Job accessibility is an important kind of accessibility, as it reflects the ease of reaching one's workplace and is critical for daily commutes. It is widely used in policy-making and is related to numerous researches topics, such as urban structure (Gao, Mokhtarian, & Johnston, 2008; Horner, 2004), jobs-housing balance (Levine, 1998), and social inequality (Grengs, 2012).

Much advance has been made in accessibility modeling, providing a rich toolbox for measuring job accessibility (Bunel & Tovar, 2013; Geurs, De Montis, & Reggiani, 2015). Most job accessibility measures employ the gravity-based model, which contains two main components: the number of job opportunities and the effect of distance decay. One development in job accessibility indicators has been to include the effect of spatial competition for jobs, as job accessibility is not only generally determined by the number of jobs but also affected by the spatial competition for them (Shen, 1998; van Wee, Hagoort, and Annema, 2001; Wang, 2012; Wang, Monzon, & Ciommo, 2015). The two-step floating catchment area (2SFCA) method is a classic model incorporating spatial competition on the supply side and the demand side (Luo & Wang, 2003). It has been widely applied in the literature on job accessibility (Boschmann & Kwan, 2010; Grengs, 2010; Hu, Fan, & Sun, 2017; Muhammad, Jong, & Ottens, 2008; Wang, 2003). In this study, it will be used as a basic model. The generalized form of the 2SFCA method is written as shown in Eq. (1).

$$AG_i = \sum_j \frac{O_j f(d_{ij})}{\sum_k P_k f(d_{kj})} \tag{1}$$

where AG_i is the job accessibility score at location i; P_k is the demand for jobs at location k; O_j is the total number of jobs at location j; d_{ij} and d_{kj} are the respective travel distances from i or k to j; and $f(d_{ij})$ is a distance-decay function.

In measuring job accessibility, the population's diversity and the related availability issues have also been addressed from workers' perspectives. That is, the job accessibility for a specific type of workers should consider the availability of opportunities in terms of social status or the transport affordability. Most studies on this topic focus on the differences between groups, especially for disadvantaged groups (Hu, 2016; Kawabata, 2003; Matas, Raymond, & Roig, 2010; Wang, 2007). Some studies also address the diversity in transportation modes to reveal the modal mismatch in job access (Grengs, 2010; Lubin & Deka, 2012; Wang & Chen, 2015). In comparison, job diversity in accessibility is seldom studied. Cheng and Bertolini (2013) made the first attempt to tackle this challenge, using an entropy approach to incorporate job diversity into an accessibility indicator. In their method, each job type's accessibility (AG_{is}) is separately calculated as shown in Eq. (4), and then Eq. (2) is used to calculate the entropy index D_i, which reflects the job diversity at location i. The range of D_i is from 0 to 1. Then, the entropy index is integrated into the traditional accessibility indicator AE, as shown in Eq. (3).

$$D_i = \frac{\sum_s (AG_{is}/AG_i) \times \ln(AG_{is}/AG_i)}{\ln(S)} \tag{2}$$

$$AE_i = AG_i^{Di} \tag{3}$$

$$AG_{is} = \sum_j \frac{O_{js} f(d_{ij})}{\sum_k P_k f(d_{kj})} \tag{4}$$

where S is the number of the job varieties; AG_i is the accessibility score at location i; AG_{is} is the accessibility score of job-type s at location i; O_{js} is the number of job-types at location j; and all other notations are the same as those in Eq. (1). It should be noted that AG_i and AG_{is} can be calculated by other accessibility measures that don't include a diversity component.

One limitation of this method is that the job diversity's impact on final job accessibility cannot be adjusted according to a particular environment, as the component of job diversity is expressed as a fixed power function. However, the same degree of job diversity may have quite different impacts on the value of accessibility. For example, a multi-worker household may love job diversity more than a one-worker household. Multi-worker households have received much attention in the literature (Surprenant-Legault, Patterson, & El-Geneidy, 2013). When explaining the issues from Hamilton's (1982) classic work of excess commuting, several studies have emphasized that different household types show differences in location choice, and job diversity may be critical for households with multiple workers (Kim, 1995). For a multi-worker household, when job diversity is low, it will be harder to find jobs together or to find a place of residence close to their workplaces (Freedman & Kern, 1997).

Compared with Western countries, the ratio of two-worker households in China is quite high, at about 77.6% in 2015 (NHFPC, 2015). This implies that in evaluating job accessibility, the love of job diversity may be much more important for Chinese cities. However, most studies of job accessibility in Chinese cities have focused on revealing the spatial structure or spatial equality (Fan, Allen, & Sun, 2014; Han, Yang, Wang, Song, & Zhang, 2015; Hu et al., 2017; Zhang & Man, 2015; Zhao & Lu, 2010). Popular accessibility measures are adopted in these studies, but neither job diversity nor love of job diversity is considered. Without considering the love of job diversity, evaluation of accessibility may be either insufficiently accurate or even misleading, at least from the perspective of two-worker households.

Inspired by the models used in NEG, this article proposes a new accessibility indicator by introducing the constant-elasticity-of-substitution (CES) function into the 2SFCA method, which can reflect both job diversity and the love of job diversity.

3. Methodology

3.1. Model modification integrating the CES function

The CES function was developed in the 1970s in the context of monopolistic competition (Dixit & Stiglitz, 1977), and has been used widely in NEG (Krugman, 1998). It can combine various types of consumption goods into an aggregate quantity. The CES function displays a constant elasticity of substitution, the parameter of which (ρ) can represent the preference for variety.

The measure of job accessibility integrating the CES function (AC) is presented in Eq. (5). The new method is capable of depicting both job diversity and the love of job diversity because parameter ρ reflects the intensity of the preference for job variety. The value of parameter ρ ranges from 0 to 1. When ρ equals 1, the different types are perfectly substitutive for one another, which indicates that people do not need diversity, and AC_i will simply equal the sum of accessibilities of all types; but when ρ decreases toward 0, the desire for a greater variety of job types increases, and so AC_i will also increase.

One advantage of the AC method is that parameter ρ can be adjusted according to local circumstances, as preference for job diversity may vary across regions or cities. For example, in cities dominated by one-work households and low-skilled jobs, the value of parameter ρ may be closer to 1. Though parameter ρ can reflect preference for job diversity, it has some limitations. For example, it cannot be used for a mix of different kinds of activities, and the parameter setting should be group specific. It also cannot be used for households with all workers in the same sector. In this study, the parameter is set at the city scale due to data availability.