A Global Transit Innovations (GTI) Product

Beijing Job Accessibility Map – Transit

Methodology Report

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Overview

The Beijing Job Accessibility Map – Transit describes the amount of job opportunities accessible by transit from each jiedao district within 30-, 45-, and 60- minutes of travel time using the Beijing Economic Census Data in years 2004 and 2013.

Data Source

Calculating job accessibility by transit requires two separate sets of data: transit network data that could be used to calculate the amount of areas reachable from each jiedao district within a predetermined travel time period; and jobs data that could be used to count the total amount of jobs within each reachable area. Table 1 below lists the data sources used in the accessibility analysis.

Table 1 Data sources used in calculating job accessibility by transit in Beijing

Transit-Based Job Accessibility	Transit Network Data	Jobs Data
2004	2005 bus stops and subway stations data collected by the research team	2004 Economic Census
2013	2015 Baidu Direction API	2013 Economic Census

Study Area

Beijing is the second most populous city in China, with a total population of 21 million as of 2013. As the capital of the country, it is unique in its development history as well as tax and subsidy system, yet representative of Chinese cities in a number of ways, including the kind of planning and land reform practices used in the city, the kind of socio-spatial polarization experienced during post-reform era, and the increasing urban sprawl observed.

Figure 1. Study area map

Figure 1 shows a map of the Beiiing region and boundaries of the region's 246 jiedaos used in creating the 2004 and 2013 job accessibility maps. Jiedao (subdistrict in Chinese) has been the basic administrative unit in Chinese cities for decades and is the lowest geographic level reported in publicly accessible government statistical reports. Note that jiedao boundary changes over years. To make the accessibility results easier to compare across years, we adjust the employment data of each year to make them match with the 2013 administrative boundary map, according to the jiedao boundary changes in these years.

Job Types

To provide more information on what types of jobs are available at different locations, we categorized jobs into two types: **skilled** jobs that may require college education and **unskilled** jobs that may not require college education.

Because there is no education requirement or attainment data at the jiedao level in the Economic Census, the identification of job types were done at the sector level using 2004 Economic Census data: We use the total percentage of workers with college education in each sector as the indicator to categorize sectors with skilled jobs and sectors with unskilled jobs. The categorization process involves two steps:

1. Calculate the % of workers with college education for each of the 18 sectors listed in Table 2, excluding the Agriculture, Forestry, Animal Husbandry and Fishery sector and the International Organizations sector.
2. If a sector has a percentage higher than the region-wide percentage (i.e., the percentage of total workers with college education in Beijing, China, which is 39% in 2004), this sector will be classified as a sector with skilled jobs. A sector with a percentage lower than the region-wide percentage of 39% will be classified as a sector with unskilled jobs. Table 2 shows the sectors identified as sectors with skilled jobs vs unskilled jobs.

It is important to note that the Wholesale and Retail Trades sector is classified as a sector with unskilled jobs although the sector has a percentage of workers with college education (40.58%) slightly higher than the region-wide percentage (39%). This adjustment was done for two reasons: (1) Jobs in the Wholesale and Retail Trades sector are somewhat seasonable. Although a significant number of people with college education work in the sector, it does not necessarily mean a significant number of jobs in this sector require college education. In other words, workers in this sector tend to be over-qualified for the jobs. (2) Classifying the Wholesale and Retail Trades sector as an unskilled sector helps to make the final percentage value of jobs in the identified unskilled sectors out of the total jobs (64% in 2004) closer to the actual percentage value of jobs with workers having college education out of the total jobs (61% in 2004).

Table 2 Sector-based Job classification

Sectors	Codes	% of workers with college education	Sectors identified with skilled jobs	Sectors identified with unskilled jobs
Agriculture, Forestry, Animal Husbandry and Fishery	A	-		
Mining	B	6.06%		√
Manufacturing	C	21.99%		√
Production and Distribution of Electricity, Gas and Water	D	34.85%		√
Construction	E	21.09%		√
Traffic, Transport, Storage and Post	F	17.28%		√
Information Transmission, Computer Services and Software	G	84.62%	√	
Wholesale and Retail Trades	H	40.58%		√
Hotels and Catering Services	I	12.95%		√
Financial Intermediation	J	70.26%	√	
Real Estate	K	35.15%		√
Leasing and Business Services	L	46.71%	√	
Scientific Research, Technical Service and Geologic Prospecting	M	70.76%	√	
Management of Water Conservancy, Environment & Public Facilities	N	21.19%		√
Services to Households and Other Services	O	21.74%		√
Education	P	72.32%	√	
Health, Social Security and Social Welfare	Q	51.36%	√	
Culture, Sports and Entertainment	R	62.62%	√	
Public Management and Social Organization	S	62.68%	√	
International Organizations	T	-		

Accessibility Calculation

This research applies a cumulative opportunity approach to calculate transit-based job accessibility at the jiedao level. As such, our accessibility calculation counts, from each jiedao centroid, the total number of jobs that can be reached within a predetermined travel time periods during morning peak hours. We use three different travel time periods, including 30, 45, and 60 minutes. Our accessibility analysis include two steps:

1. Generate transit travel time matrix describing the shortest transit travel time between any pair of jiedaos; and
2. For each jiedao, based upon the transit travel time matrix, identify all the jiedaos that are accessible from the jiedao centroid within 30-, 45-, and 60 minutes of transit travel, and add up all the jobs in the identified accessible jiedaos.

Step 1: Generate transit travel time matrix

For each pair of jiedaos, we calculated 2005 and 2015 transit travel time. From a jiedao centroid to another jiedao centroid, the transit travel time includes bus/rail riding time, walking time (from the origin jiedao centroid to the starting transit stop and from the ending transit stop to the

destination jiedao centroid), and waiting time which is dependent upon frequency/headway of the specific bus route at specific time of the day.

The 2005 transit network data only has stop/station location data, and does not have schedule data. To derive the 2005 bus/rail riding time and walking time, morning peak speed assumptions were made for each possible transit trip mode, as shown in Table 2. In addition, for all 2005 calculations, a default 5-mintue waiting time was assumed at each transfer.

Table 2. Speed assumptions used to derive 2005 transit travel time

Travel Mode	Morning Peak Hour Speed
Bus	12 km/h
Suburban Bus	15 km/h
Subway	35 km/h
Walking	5.5 km/h

The 2015 transit travel time between each pair of jiedao centroids came directly from the Baidu Direction API. Baidu Direction API allows the user to query travel directions and total travel time between any two points (as long as the longitudes and latitudes are given) using either the car or transit mode. See more details about Baidu Direction API at http://developer.baidu.com/map/index.php?title=webapi/direction-api. The total transit travel time given by the Baidu Direction API automatically includes bus/rail riding time, walking time (from the origin jiedao centroid to the starting transit stop and from the ending transit stop to the destination jiedao centroid), and waiting time which is dependent upon frequency/headway of the specific bus route at specific time of the day. To generate morning peak-hour transit travel time, we only queried the Baidu Direction API during 7 – 9 am local time in Beijing.

Step 2. Add up jobs to calculate 30-, 45-, and 60-minute job accessibility

As mentioned earlier, this research uses the cumulative opportunity approach to calculate accessibility. The formula we used is below:

$$a_i = \sum_{j=1}^{n} e_j f(t_{ij}) \quad (1)$$

$$f(t_{ij}) = \begin{cases} 1;\ if\ t_{ij} \leq 30, 45, or\ 60\ mins \\ 0; if\ t_{ij} > 30, 45, or\ 60\ mins \end{cases} \quad (2)$$

where,

a_i represents the composite counts of jobs (employment) accessible within 30, 45, or 60 minutes of transit travel from jiedao i. As illustrated in Equation 1, whether jobs are considered as accessible is dependent upon based upon a travel time threshold function $f(t_{ij})$. t_{ij}represents the travel time by transit between the centroid of jiedao i and the centroid of jiedao j.

Concluding Remarks

To enable comparison of accessibility measures across years, we tried to use the same accessibility calculation methods across years and use comparable data sources across years. However, we were not able to obtain transit network data in 2004 and 2013. Instead, we used 2005 transit network data in calculating 2004 accessibility and 2015 transit network data in calculating 2013 accessibility. There is also methodological difference in Step 1: Generate Transit Travel Time Matrix between 2005 and 2015, which may affect comparability. Nonetheless, our accessibility comparison used the best data available and provide important insights into how transit-based job accessibility has changed over time at the jiedao level.