Impact of Transportation on the Employment of the Low-income Groups - Case study of Small-Scale Questionnaire in Beijing

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1 Introduction

China's megacities are undergoing rapid urbanization and extensive rail transit construction. Transport infrastructure is becoming increasingly important for the employment of the poor in China's megacities. Beijing, the country's political, economic and cultural center, is China's second largest city with an estimated 2015 population of 21.7 million. The city contains 666 kilometers of rail transit. Although it is one of the cities with highest GDP in China, poverty has not completely disappeared. In fact, with the rise of housing prices and widening economic inequality in recent years, poverty-related urban problems are becoming more prominent. In large-scale affordable housing communities and in suburban fringe areas around the city where low-income groups are concentrated, the impact of transportation infrastructure for the employment accessibility of low-income groups is critical.

Rapid suburbanization in Beijing has changed the relationship between jobs and housing (Wang, Song et al., 2011);the "spatial bond" that existed during the planned-economy era has given way to a "spatial mismatch" in the current transition period. Most urban employment is concentrated in the center of the city, while residential housing is primarily located in the suburban areas where many new, affordable housing have been built (Zhang Chun, Yi Chengdong, Song Yan, 2016). Transport infrastructure that connects suburban affordable housing for low-income groups to the urban city center where jobs are located is critical for low-income workers.

Transport infrastructure is not only important for reducing unemployment, it also improves overall urban quality of life in several areas. First, workers in large cities often commute long distances and the costs associated with commuting may adversely affect their overall household economic condition (Henry and Goldstein, 2010). Second, in addition to direct economic costs, long commutes impact the types of employment available to low-income workers, thus reducing employment rates of effective labor market (Kawabata, 2003; Baum, 2010). Finally, commuting also affects job satisfaction and overall quality of life (Zhao and Lu, 2009). Research has shown that transport infrastructure is important to increasing the employment rate of low-income groups. This is particularly important in China's megacities where multiple city centers and extensive suburbanization have impacted spatial relationships between jobs and housing (Hu, 2015).

In addition to theoretical research, a number of international and domestic case studies have also begun to focus on the interrelationships among employment accessibility, long-distance commuting and jobs-housing relationship in Beijing. For example, some scholars found that the one-way commuting time in 2008 in Beijing

is about 46 minutes on average based on a large sample of traffic survey (Liu and Wang, 2011). Recently, Beijing City Laboratory found that there are nearly 112,000 people who swipe the bus card more than three times a day and spend more than 90 minutes on commuting based on bus card data research (Long Ying, Zhou Jiang, 2013). According to estimates, the transit commuting index in Beijing is about 28%, which reflecting the overall jobs-housing conditions (Zhou, Zhang and Chen, 2014).According to the analysis of the travel data of the bus card, we can identify the extreme commuting phenomena such as the early-out, late-return, long-time and multi-transfer, which shows that in the condition of transport infrastructure imbalance in large cities, the low-income groups will encounter more constraints and difficulties in employment (Long, Liu and Zhou, 2015). In addition, some scholars directly examined the spatial distribution of the unemployed population in Beijing, and found that in addition to the supply and demand of labor and employment structure changes, the imbalance of overall jobs-housing spatial relationship and the poor employment accessibility in the local are also the main reason lead to local unemployment (Yi and Zhang, 2015).

Despite continuous investment in urban transport infrastructure in recent years, low-income workers in megacities such as Beijing experience employment difficulties in part from uneven development in urban housing and public transportation. Rapid urbanization and rail transit construction in Chinese cities has transformed the role of transport infrastructure beyond merely technology to a catalyst for economic and social development. This study investigates the impact of public transport infrastructure on employment of low-income workers in metropolitan Beijing. A sample of one thousand individuals were surveyed using a questionnaire to gather data on the jobs-housing relationship, employment satisfaction, and employment status based on different public transport facilities. Data collected includes individual and family attributes, travel characteristics, travel satisfaction, and employment characteristics. Selecting the low-income neighborhoods as survey sites, these data were supplemented to the large sale trip survey by BJTRC, to examine the impact of local public transport infrastructure on urban employment.

2 Research Methods, Cases and Data

2.1 Research Methods

Two approaches are mainly used to evaluate the impact of public transport infrastructure on job satisfaction in Beijing. First, the relationship between the employment and residential space on the scale of

sub-district and townships is measured to find the characteristics and changes of the spatial relationships around the public transport corridors. Special attention is paid to the spatial relationship of jobs and housing for residents living in government-subsidized housing to measure the impact on low-income workers. Second, survey data was collected from people/households in two suburban affordable housing communities (sample sizes of 400 and 250) and an urban employment center (sample size of 350). Logit regression analysis is used to examine the effect of individual and family attributes and travel characteristics on employment status and employment satisfaction.

2.1.1 Urban Jobs–Housing Spatial Relationship Based on the JHB Index

The job-housing balance (JHB) index is one measure of overall employment and living conditions, although the index does not adequately reflect employment accessibility. In the case of Beijing, the ratio of the number of jobs and the number of basic units is used to evaluate the jobs-housing balance usually with residential district or traffic analysis units (TAZ) as the basic unit (Weitz and Schindler, 1997). The JHB index shows the ability of the basic employment unit to have employment opportunities, wherever it is in employment-intensive areas or living-intensive areas (Weitz, 2003).

The potential problem in measuring the JHB index is that even if the employment and residence positions are balanced in number, it does not mean that all of the resident population in the district is employed in the same district.

2.1.2 Logistic Regression Model Regression

In addition to examining jobs–housing spatial relationships, logit multiple regression analysis was conducted using the household survey data to examine the effects of personal attributes and trip characteristics on employment status and satisfaction. The questionnaire collected information on job satisfaction, travel satisfaction, and employment status to examine the impact of public transportation infrastructure on the labor market of low - income earners. Forr the Logit regression model, we try to find the effect of individual attributes and trip characteristics on travel patterns by setting some cross terms, such as income and means of transportation, education and means of transportation, etc.

2.2 Selection of the Investigation Cases

One thousand household samples were randomly selected in three different locations in Beijing. Two were in affordable housing complexes: 250 surveys were conducted in Tongzhou Beiyuan on subway line 1and 400 surveys were conducted in Chaoyang Changying on subway line 6. An additional 350 surveys were conducted at an employment center and rail transit hub in Xizhimen. All the surveys were conducted in the morning and evening peak periods in the residential community in the radius of 1 km from the subway station (Figure 1, Table 1):

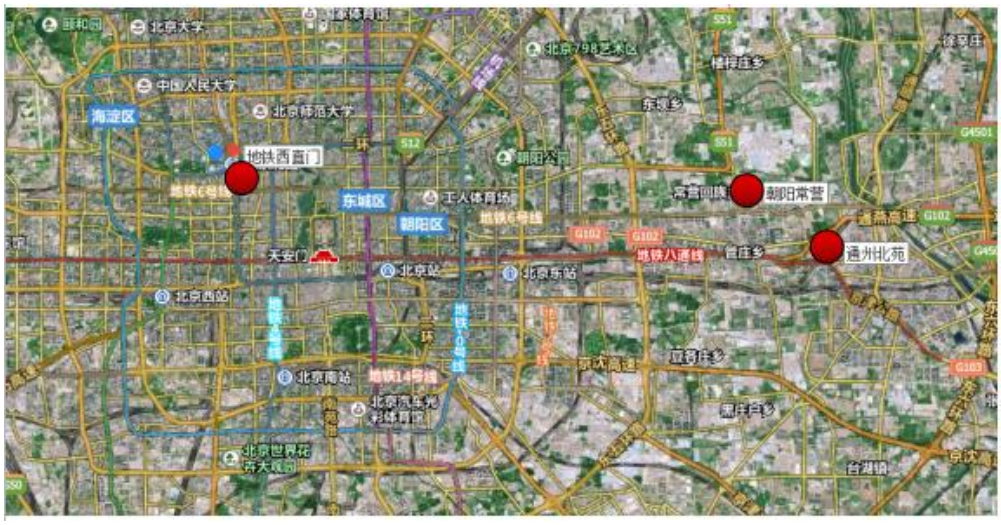

Figure 1. The location of the three survey cases in the metropolitan area of Beijing

Table 1. Locations, numbers and representativeness of the questionnaire survey

Research Location Number	Number of samples	Research Location	Representation of location
1	350	Xizhimen	employment center and rail transit hub
2	400	Chaoyang Changying	the affordable housing concentrated community along subway line 6
3	250	Tongzhou Beiyuan	the affordable housing concentrated community along subway line 1

2.3 Characteristics of Employment and Residential Space in Three Research Cases

2.3.1 Characteristics of employment locations in Tongzhoubeiyuan

Questionnaire in Tongzhoubeiyuan neighborhood is mainly carried out among the middle- and low-income groups along the Subway Line 1. Tongzhoubeiyuan is located between the fifth and sixth ring roads in the eastern suburbs of Beijing. It is about 20km from the city center. Many people living here are able to access employment in the city center because of the subway. Analysis of employment locations shows several major employment patterns: one around the Tongzhoubeiyuan subway station and a second along subway Line 1, especially in Sihui of Chaoyang District, Guomao and other sites. There are also a small number of people working in other areas such as Wangjing and Liangmaqiao which is in the north of Beijing.

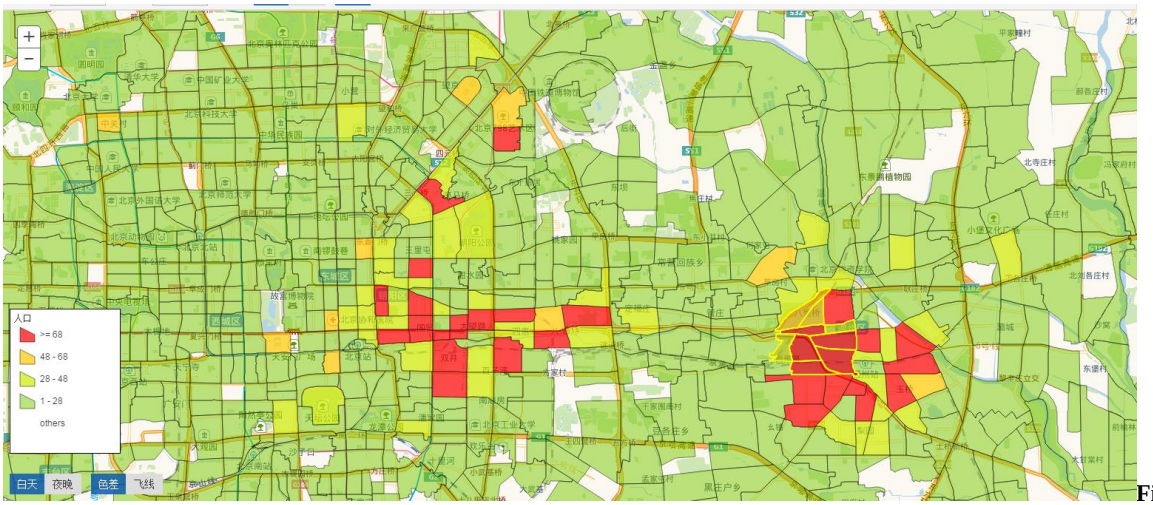

Figure 2. Distribution of employment location for Tongzhoubeiyuan residents

2.3.2 Characteristics of employment locations in ChaoyangChangying

Questionnaire in the Changying neighborhood of Chaoyang District were mainly conducted with middle- and low-income individuals living along subway Line 6. Changying is located in the eastern section of Beijing near the Fifth Ring Road and is near subway Line 6. By mapping the employment locations, the jobs-housing spatial relation (Figure 3) for Changying residents show a relatively dispersed pattern of employment in the eastern part of Beijing. Some work locally in Changying. Some work in the area along the subway Line 6, but

most of the jobs are located along the subway Line 1 near the China World Trade Towers, Shuangjing, and other locations. Others work near the 798 Art District, Wangjing or Liangmaqiao in the northeast part of Beijing and in the Zhongguancun area northwest Beijing.

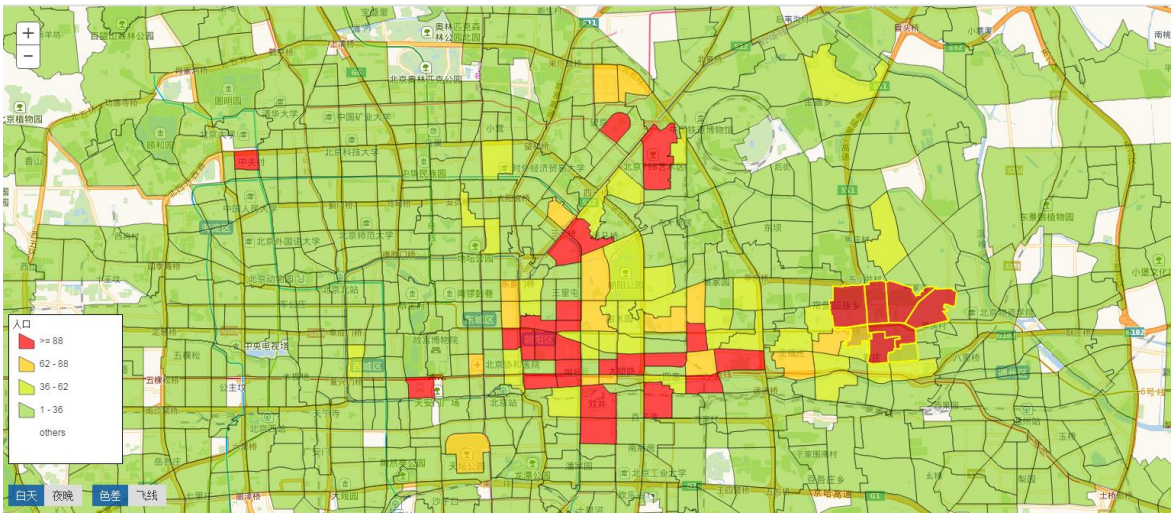

Figure 3. Distribution of employment location for Changying residents

2.3.3 Characteristics of residential locations in Xizhimen

Xizhimen is a transportation hub for Line 4, Line 2 and Line 13, and it is a commercial center with rather high population density. The job-housing spatial characteristics data for Xizhimen residents (Figure 4) show widely scattered employment patterns. Some work in universities in the surrounding area such as Beijing Normal University, Beijing Jiaotong University, and Beijing Foreign Studies University. Others work in areas that are accessible by subway such as Fuxingmen (Line 2) and Zhongguancun (Line 4), as well as Wudaokou (Line 13), Guanganmen (Line 1)，Haidianwuluju (Line 6), and places around Chaoyang International Trade and Dongzhimen (Line 2).

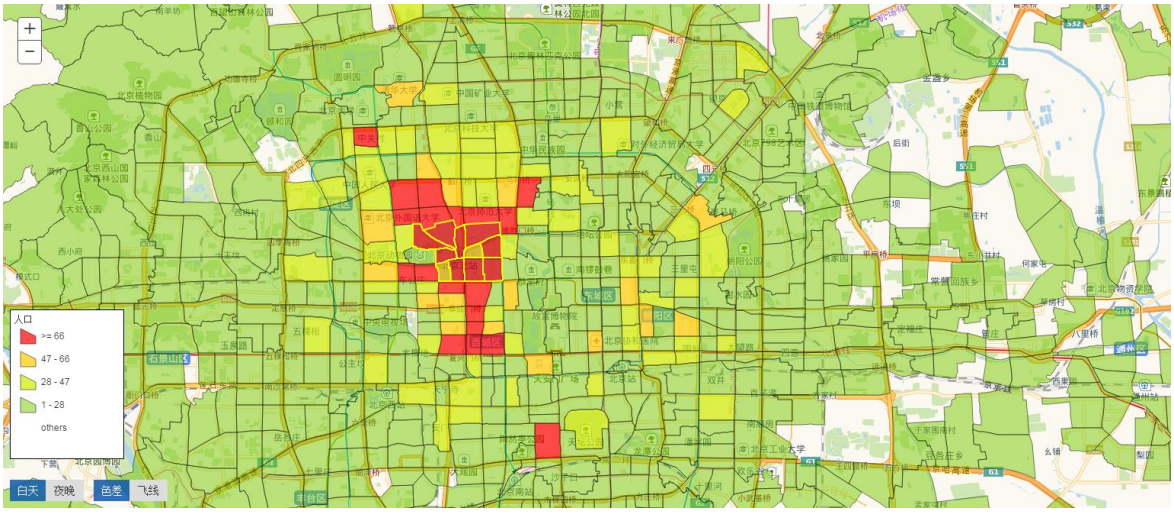

Figure 4. Distribution of residential location for respondents in Xizhimen

2.4 Questionnaire design and data acquisition

Detailed data on commuting and employment were collected from workers, in order to examine the relationship between transport facilities and the replacement of residence and workplace.

The questionnaire included personal attributes (age, gender, income, educational level, and family status), employment location and commuting behavior (residence and work addresses, average time spent commuting and actual time of the commute, interchange process and mode of transport), commuter preferences (longest acceptable commute, activities arranged on the way to work and home) and employment success (job satisfaction, employment status).

In the regression model, it takes the commuting time(X_1),commuting mode（X_2）,commuting time * bus travel mode（X_3）,revenue * public travel mode(X_4),respondent age (X_5),the square of the age of the respondents (X_6), the respondents gender (X_7), the number of respondents (X_8), property ownership (X_9) and the average monthly household income (X_{10}) as the independent variable, and takes employment status （Y_1）and job satisfaction（Y_2）as the dependent variable performed the multiple Logit model linear regression. The regression models were (Table 2):

$$Logit(Y_1) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10}$$

and

$$Logit(Y_2) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10}$$

Table 2. Spatial Regression Model of Urban Internal Scale

variable	Measurement method	unit

Independent variable		
Commute time X_1	The time of One-way commuting	minute
Commute time X_2	The means of transportation used at work (Car / Bus, Other)	Categorical variables
Commuting time * public transport, other travel modes X_3	One-way travel time * Use non-car travel	Crossover variable
Income * bus, other travel modes X_4	Income Level * Use non-car trips	Crossover variable
Age X_5	How many years old	Year
The square of the age of the respondents X_6	Age of respondents * Age	Year
The respondents gender X_7	Sex of the surveyed person (male / female)	Categorical variables
The number of respondents X_8	Population in the family	Person
Property ownership X_9	own property rights or not（yes/no）	Categorical variables
The average monthly household income (X10)	Average monthly household income（2000 yuan or less；2000-5000 yuan；5001-10000 yuan；10001-20000 yuan；20000 or more）	Categorical variables
Dependent variable		
Employment Status Y_1	Full-time / part-time, no job	Categorical variables
Job SatisfactionY_2	Very satisfy / Satisfy / Average / dissatisfy / Very dissatisfy	Categorical variables
Job Accessibility	Commuting time	Min

2.5 Characteristics of Samples in the Survey

The samples were randomly chosen in three neighborhood as individual respondents. By interviewing the respondent of working age from 15 to 65 by structured questionnaire, the data were collected.

A total of 1,000 questionnaires were distributed in the three sites; 912 were completed for a 91.2 percent response rate. Approximately one-quarter of respondents reports monthly household incomes of less than RMB 5,000 and another 35 percent reports monthly household incomes between RMB 5,000-10,000. Sample

respondents were much more likely to be employed full time (87%) than part time (13%). The average commuting time of sample respondents was 55 minutes on one way; the vast majority of respondents commuted by public transportation or other means of transportation (80%) rather than private cars (20%). As for job satisfaction, 67 percent of respondents reported being very satisfied or satisfied, which means that most of them show positive attitude towards job satisfaction.

Table 3. Basic Attributes of Questionnaire Samples

Variables	Unit	Sample Number	Average or Percentage (%)
Commute time	min	838	54.98
Commute mode	Cars	149	19.74%
	Public Transport & Others	606	80.26%
Age	Year	912	34.53
Gender	Male	443	49.22%
	Female	458	50.88%
Property ownership	Yes	553	71.73%
	No	218	28.27%
Household Average Income	Below2000yuan	20	2.66%
	2000－5000yuan	179	23.80%
	5001－10000yuan	262	34.84%
	10001－20000yuan	199	26.46%
	Above20000yuan	93	12.37%
Working Status	Full-time	721	86.76%
	Part Time Jobs	111	13.36%
Job Satisfaction	Very Satisfied	60	15.58%
	Satisfied	199	51.69%
	Neutral	113	29.35%
	Dissatisfied	7	1.82%
	Very Dissatisfied	6	1.56%

2.6 Personal attributes with different length of commuting time

The average commuting time is 54.98min for all the respondents. And They are divided into two groups: long time commuting group (>=55min) and short time (<55min), a commuter group by comparing the observation of individual property consolidation, the differences between the two groups of residents.

Among them, 385 respondents were included in the long distance commuting time group, and the short time commuting group included a total of 452 respondents. From the commuting and whether the property owned housing on the two variables, public transportation or other means are as the main way of choosing two groups of traffic and the proportion reached 68.52% and 72.48%, and in the housing property were 74.60% and 68.98% of the respondents choose to have housing property from the family; the average monthly income, the average monthly income of two groups in the number of 5000 to 20000 yuan for the majority, but low income, long time commuting group of low-income small proportion of less than 1%, a short time commuting group of low income ratio reached 4%, the low income of the respondents are 88.89% there is a short time commuting; from the working state of view, long time commuting without people who work part-time or group accounted for less than a short time commuting group; on the job satisfaction of residents, a short period of time Commuter group selection satisfaction was very satisfactory accounted for 18.31% of the selection are not satisfied with only 0.94%, while the long time commuting group were 12.02% and 2.53%, visible short commutes easier for people to bring contentment.

Table 4. Characteristics of long and short commuters

		A Long commuters (>=55min)		B Short commuters (<55min)	
	Unit	Sample Number	Average or Percentage (%)	Sample Number	Average or Percentage (%)
Commute mode	Cars	119	31.48%	120	27.52%
	Public Transport & Others	259	68.52%	316	72.48%
Age	Year	385	34.07	452	34.04
Gender	Gender	194	50.92%	213	47.58%
	Female	187	49.08%	234	52.47%
Property ownership	Yes	232	74.60%	278	68.98%
	No	79	25.40%	125	31.02%
Household Average Income （yuan）	Below2000yuan	2	0.63%	16	4.16%
	2000~5000yuan	60	18.87%	103	26.75%
	5001~10000yuan	125	39.31%	120	31.17%
	10001~20000yuan	88	27.67%	103	26.75%
	Above 20000yuan	43	13.52%	43	11.17%
Working Status	Full-time	340	94.44%	355	85.33%
	Part Time Jobs	20	5.56%	61	14.67%

	Very Satisfied	19	12.02%	39	18.31%
	Satisfied	82	51.90%	93	43.66%
	Neutral	51	32.28%	54	25.35%
Job	Dissatisfied	2	1.27%	5	2.35%
Satisfaction	Very Dissatisfied	4	2.53%	2	0.94%

3 Regression Analysis of all Samples from the Questionnaire

3.1 Employment status impact factors

Regression analyses are conducted to explore the effects of traffic-related factors and individual attributes on employment status and employment satisfaction. Independent variables include commute time (X_1), travel mode (X_2), commute time * public travel mode (X_3), income * public travel mode (X_4), age (X_5), the square of the age of the respondent (X_6), respondent's gender (X_7), family size (X_8), property ownership (X_9), and average monthly household income (X_{10}). Employment status and job satisfaction were the dependent variables.

The results for employment status are shown in Table 5.

$$Logit(Y_1) = 0.384 + 0.001X_1 + 0.066X_2 - 0.001X_3 - 0.003X_{4+} 0.026X_5 - 0.042X_7 + 0.010X_8 + 0.015X_9 + 0.044X_{10}$$

In the model, the value of R^2 is not higher than 0.052 overall. Age, the square of the age of the respondents, and gender were significant in predicting employment status. Older respondents were more likely to be employed full-time ($\beta_5 = 0.026$, $Sig_5 = 0.012$) and women were less to work full-time ($\beta_7 = -0.042$， $Sig_7 = 0.050$). These results match what other studies have found. The number of family members, home ownership, and average monthly household income were not significant. Neither commuting time ($\beta_1 = -0.001$, $Sig_1 = 0.472$) nor commuting mode ($\beta_2 = 0.066$， $Sig_2 = 0.533$) were significant, which means the relationship between the length of commuting time and employment status is not obvious.

Table 5. Regression Model of Individual Employment Status

Variable	Unit	Statistic index	
		β	Sig

R^2	0.052		
Constant		.384	.069
Explanatory Variables			
X_1 Commute Time	min	.001	.472
X_2 Commute Mode	Buses and others =1， Cars =0	.066	.533
X_3 Commute Time * Public Transport / Others	Crossover Variable	-.001	.311
X_4 Household Average Income * Public Transport /Others	Crossover Variable	-.003	.915
X_5 Age	Year	.026	.012
X_6 Age of respondents * Age	Year	.000	.002
X_7 Gender	Male=1 Female=2	-.042	.050
X_8 Family Size	Person	.010	.306
X_9 Property owership	Yes=1 No=0	.015	.579
X_{10} Household Average Income	Below2000=1 2000-5000=2 5001-10000=3 10001-20000=4 Above20000=5	.044	.053
Dependent Variable. working status	Full-time job=1， Part-Time Job or Unemployed =0		

Commute time (X_1) and commute mode (X_2) are not significant separately. In order to compare with the case of Urumqi, it still use the cross variables in this case. And the results of cross-variables are as follows: 1) commute time * public transport /others and income * public transport / others - change from

positive to negative (β_3=-0.001， Sig_3=0.311). 2) The crossover variable X_3 - commute time * public transport/other is still not significant. 3) Cross-variable income * public transport/other becomes insignificant (β_4 = -0.003, Sig_4 = 0.915). This implies that for the employment state, coefficient of the crossover variable may be opposite to that of the single factor influence, and there is no inevitable correlation with the significance of the single factor effect. At the same time, the crossover setting also reflects the different impacts of public transport on employment status, but still all the cross-variables are not significant.

3.2 Job satisfaction impact factors

In addition to employment status, job satisfaction is also an important indicator to measure the degree of employment success. In the following model, job satisfaction is measured along a five-point scale ranging from very dissatisfied to very satisfied (complete results are presented in Table 6).

$$Logit(Y_2) = 1.788 + 0.001X_1 + 0.154X_2 - 0.005X_3 - 0.013X_4 + 0.022X_5 + 0.168X_7 + 0.029X_8 + 0.013X_9 + 0.082X_{10}$$

The coefficient R^2 of the regression model is 0.021 which is still not high. Among the factors affecting job satisfaction, only the female (β_6=0.168， Sig_6=0.070) shows significant effects in the model, that is, the job satisfaction of women is higher than men. Among other personal attributes, the influence of variables such as age, the square of the age, family population, property ownership, and household income are not significant.

As for the transportation related factors, commuting time (β_1=-0.001， Sig_1=0.755) and commuting mode (β_2=-0.154， Sig_2=0.745) were also not significant. This finding is in contrast to traditional assumptions about job-housing spatial relationship, which emphasizes that longer commuting might induced lower level of job satisfaction. Perhaps the factors impacting job satisfaction in the Beijing metropolitan area are complex and single variable such as commute time and commuting mode do not capture the complexity of factors influencing job satisfaction.

Of the two crossover variables, the influence coefficient of the commutation time * bus (X_3) is negative and is still not significant (β_3 = -0.005, Sig_3=0.124). Relative to the single variable regression of commute time (X_1), the significance level is increased from Sig_1=0.755 to Sig_3=0.124, indicating that with the increasing of commute time, job satisfaction of commuters who choose public transport and other modes of transportation

would be significantly reduced. While for car commuters, the effect of commuting time on job satisfaction is insignificant, which shows the difference in the impact of different modes of transportation. For the other cross-variable, income * bus (X_4), the impact of significance is still not high, indicating that impact of different income levels and modes of transport on the joint job satisfaction is not obvious. The regression model added crossover variables shows that the influence of commuting time with different modes of transport on job satisfaction is different.

The impact of transport infrastructure on employment of low-income groups in Beijing may be complex and multi-dimensional, and most of the variables are not significant. Therefore, a more detailed discussion should be targeted at different locations or different groups of people in the next step of the study. Multinomial logit model reports similar results, comparing with linear model.

Table 6. Job Satisfaction Regression Model of Beijing Individual Traffic Survey Data

Variable	Unit	Model of Working State	
		β	Sig
R^2	.021		
Constant		1.788	.018
Explanatory Variables			
X_1 Commute Time	min	.001	.755
X_2 Commute Mode	Buses and others =1，Cars =0	.154	.745
X_3 Commute Time * Public Transport / Others	Crossover Variable	-.005	.124
X_4 Household Average Income * Public Transport /Others	Crossover Variable	-.013	.915
X_5 Age	Year	.022	.517
X_6 The quarter of the age	Year	.000	.535

X_7 Gender	Male=1 Female =2	.168	.070
X_8 Family population		.029	.420
X_9 Property	Yes=1 No=0	.013	.893
X_{10} Household Average Income	Below2000=1 2000-5000=2 5001-10000=3 10001-20000=4 Above20000=5	.082	.439
Dependent Variable.			
Job Satisfaction	Very Satisfied =4， Satisfied =3， Neutral=2， Dissatisfied=1， Very Dissatisfied=0		

Table 7. Job Satisfaction of Multinomial Logit model of Beijing Individual Traffic Survey Data

Y Job Satisfaction		**Unit**	**B**	**Sig.**
Y= 0	Constant		-16.842	.991
	X_1 Commute Time	min	.035	.505
	X_2 Commute Mode	Buses and others =1， Cars =0	51.227	.994
	X_3 Commute Time * Public Transport / Others	Crossover Variable	.021	.708
	X_4 Household Average Income * Public Transport /Others	Crossover Variable	-13.803	.993
	X_5 Age	Year	.837	.689
	X_6 Age of respondents * Age	Year	-.023	.569

	X_7 Gender	Male=1 Female=2	-2.518	.082
	X_8 Family Population	Person	-.713	.145
	X_9 Property	Yes=1 No=0	.471	.687
	[X_{10} Household Average Income=1.0]	Below2000=1 2000-5000=2	-24.468	.
	[X_{10} Household Average Income=2.0]	5001-10000=3 10001-20000=4	-11.637	.997
	[X_{10} Household Average Income=3.0]	Above20000=5	-.464	1.000
	[X_{10} Household Average Income=4.0]		14.178	.993
	[X_{10} Household Average Income=5.0]		0c	.
Y=	Constant		-30.077	.996
1	X_1 Commute Time	min	.032	1.000
	X_2 Commute Mode	Buses and others =1， Cars =0	19.398	.999
	X_3 Commute Time * Public Transport / Others	Crossover Variable	-.078	.999
	X_4 Household Average Income * Public Transport /Others	Crossover Variable	-.125	1.000
	X_5 Age	Year	-.174	.641
	X_6 Age of respondents * Age	Year	.003	.612
	X_7 Gender	Male=1 Female=2	-.873	.379
	X_8 Family Population	Person	.026	.945
	X9 Property	Yes=1 No=0	.223	.821
	[X_{10} Household Average Income=1.0]	Below2000=1 2000-5000=2	14.011	.
	[X_{10} Household Average Income=2.0]	5001-10000=3 10001-20000=4	-.164	1.000

	[X_{10} Household Average Income=3.0]	Above20000=5	15.293	.998
	[X_{10} Household Average Income=4.0]		14.999	.997
	[X_{10} Household Average Income=5.0]		0c	.
Y=2	Constant		1.668	.585
	X_1 Commute Time	min	.008	.685
	X_2 Commute Mode	Buses and others =1，Cars =0	-3.754	.140
	X_3 Commute Time * Public Transport / Others	Crossover Variable	.005	.809
	X_4 Household Average Income * Public Transport /Others	Crossover Variable	1.000	.127
	X_5 Age	Year	-.056	.725
	X_6 Age of respondents * Age	Year	.001	.653
	X_7 Gender	Male=1 Female=2	-.364	.389
	X_8 Family Population	Person	-.239	.151
	X9 Property	Yes=1 No=0	-.329	.462
	[X_{10} Household Average Income=1.0]	Below2000=1 2000-5000=2	19.367	.997
	[X_{10} Household Average Income=2.0]	5001-10000=3 10001-20000=4	3.374	.055
	[X_{10} Household Average Income=3.0]	Above 20000=5	1.301	.225
	[X_{10} Household Average Income=4.0]		.313	.670
	[X_{10} Household Average Income=5.0]		0	.
Y=3	Constant		2.092	.463
	X_1 Commute Time	min	.042	.020
	X_2 Commute Mode	Buses and others =1，Cars =0	-1.829	.448

X_3 Commute Time * Public Transport / Others	Crossover Variable	-.042	
X_4 Household Average Income * Public Transport /Others	Crossover Variable	.973	.117
X_5 Age	Year	-.106	.482
X_6 Age of respondents * Age	Year	.001	.483
X_7 Gender	Male=1 Female=2	-.198	.613
X_8 Family Population	Person	-.204	.185
X9 Property	Yes=1 No=0	-.326	.431
[X_{10} Household Average Income=1.0]	Below2000=1 2000-5000=2	19.033	.997
[X_{10} Household Average Income=2.0]	5001-10000=3 10001-20000=4	2.884	.081
[X_{10} Household Average Income=3.0]	Above20000=5	1.107	.264
[X_{10} Household Average Income=4.0]		.240	.715
[X_{10} Household Average Income=5.0]		0	.
Job Satisfaction	Very Satisfied =4， Satisfied =3， Neutral=2， Dissatisfied=1， Very Dissatisfied=0		

3.3 Commuting time impact factors

In this part, it selects commuting time to measure job accessibility, and explores its impact factors. The regression analysis of traffic survey data in Beijing uses commuting time as the dependent variable. Age, gender, number of households, home ownership, and family monthly income are independent variables.

The regression results show that the overall R^2 of sample regression is low, moreover, none of the independent variables is significant in predicting commuting time. These findings differ from the traditional hypothesis. It is possible that factors affecting commute time in a large metropolitan city like Beijing are complex and very few factors are significant.

Table 8. Commuting time regression model of Beijing traffic survey data

Variables	Unit	Commuting time model	
		β	Sig
R^2	.006		
Constant		16.246	.576
Explanatory Variables			
X_1Age	Year	1.542	.325
X_2Age*Age	Year	-.017	.420
X_3 Sex	Male=1 Female=2	.175	.958
X_4 Family Population	Person	.575	.692
X_5 Own Property	Yes=1 No=0	-3.341	.425
X_6 Average Family Income	Below 2000=1 2000-5000=2 5001-10000=3 10001-20000=4 Over 20000=5	1.804	.335
Dependent variable			
Commuting Time	min		

4 Regression Analysis on Specific Groups

According to the regression analysis of all samples, the impact of transportation infrastructure on the success of employment is different for different groups. This section will focus on employment status and job satisfaction gap between the low-income and high-income groups, and the gap between public transit users and car users.

4.1 Regression Analysis of the low - income groups and high - income groups

According to previous literature, the employment of low-income groups in the labor market is more dependent on transportation infrastructure, comparing to the overall sample regression results. In this section, we will identify the samples of lower- and middle-income groups and find out the influencing factors of their employment status and job satisfaction.

The average annual wage in 2015 in Beijing was 85,038 yuan and the average monthly wage was 7,086 yuan. Minimum wage in Beijing at that time was 1,890 yuan per month (China Statistic Year Book, 2016). Based on the average wage level of the city and the average household income from the survey data, this study defines average household monthly wages of less than 5,000 yuan as the low-income (the last 40%). There were 199 respondents identified as the low-income groups in the sample (21.8% of total sample).

Table 9. The Regression Model of the Employment Status of the Low - income Group in Beijing

Variable	Unit	Working State Model	
		β	Sig
R^2	.155		
Constant		-.583	.375
Explanatory Variable			
X_1 Commuting Time	min	.003	.328
X_2 Commuting Mode	Public Transit& Other means of transportation=1，Cars=0	.254	.635
X_3 Commuting Time*Public Transit& Other means of transportation	Crossover Variable	-.003	.377
X_4 Household Average Income*Public Transit&	Crossover Variable	-.004	.988

	Other means of transportation			
First, the regression model predicting employment status of the low-income groups explains more of the variation than for the combined sample (R^2= 0.155). Results indicate that commuting time and commuting mode are not significant predictors of employment status. Age was significant. Older respondents are more likely to work full-time. Family structure was also significant with respondents from larger household more likely to be employed full time. Gender, average monthly household income, and home ownership are not significant. The crossover variables commuting time * public transit and other modes of travel and average household income * transit were not significant.	X_5 Age	Year	.045	.045
	X_6 Age*Age		-.001	.011
	X_7 Gender	Male=1 Female=2	-.035	.560
	X_8 Family Population	Person	.051	.031
	X_9 Owning Property	Yes=1 No=0	.040	.536
	X_{10} Household Average Income	Below 2000=1 2000-5000=2 5001-10000=3 10001-20000=4 Above 20000=5	.251	.338
Predicting employment status	Dependent Employment Status	Full-time=1， Part-time Jobs or Unemployed=0		

Similar results were found for respondents from households with high average monthly. Incomes, travel mode and travel time were not significant predictors of employment status. Age was positively correlated with full-time employment, but family structure was not significant.

The regression model predicting job satisfaction for middle- and low-income groups explains more of the variation than the combined samples（R^2＝0.217）. The result shows that the commute time and commuting mode are not significant predictors of job satisfaction either as independent variables in the model or as

interaction effects. None of the other demographic variables was significant with the exception of property ownership（β_9=-0.380，Sig_9=0.090）, which suggests that owning property reduces job satisfaction (Table 10).

Table 10. The Regression Model of the Job Satisfaction of Low - income Group in Beijing

Variable	Unit	Job Satisfaction Model	
		β	Sig
R^2	.217		
Constant		2.815	.125
Explanatory Variable			
X_1 Commuting Time	min	.009	.412
X_2 Commuting Mode	Public Transit & Other Means of transportation=1，Cars=0	.730	.347
X_3 Commuting Time*Public Transit & Other Means of transportation	Crossover Variable	-.015	.176
X_4 Household Average Income* Public Transit & Other Means of transportation	Crossover Variable	Excluded	
X_5 Age	Year	-.042	.559
X_6 Age*Age	Year	.001	.502
X_7 Gender	Male =1 Female =2	-.045	.843
X_8 Family Population	Person	-.026	.739
X_9 Owning Property	Yes=1 No=0	-.380	.090
X_{10} Household Average Income	Below 2000=1 2000-5000=2 5001-10000=3 10001-20000=4 Above 20000=5	.168	.799

Dependent Job Satisfaction	Very Satisfied =4， Satisfied =3， Neutral =2， Dissatisfied=1， Very Dissatisfied=0

4.2 Regression analysis of public transit users and non-public transit users

This part divides all the samples into two groups: public transit users and non-public transit users. The impact of public transportation on employment status and job satisfaction might be different among the two groups. Previous regression result does not show significance on travel mode.

However, according to the case study did in Beijing before, the commuting time of commuters who travel by public transit is about twice as long as that of commuters traveling by bicycles thus they are at a disadvantage in the job market (Zhang and Man, 2015). In this study, we choose to samples travel by public transport for analysis, in order to find the factors employment status and job satisfaction of public transport travel groups. By selecting bus, subway / light rail and other means of public transport, a total of 606 samples are selected for analysis, accounting for 80.26% of the total samples; a total of 250 samples traveling by private cars counts 27.41% of the total sample survey.

Similar to the regression results for low-income groups, R^2 (0.113) in the regression model has improved compared with the overall sample regression in the regression for employment status. Among the factors related to commuting, commuting time and commuting mode are excluded. Age showed a significant positive effect (β_5=0.038，Sig_5=0.002) indicating that older public transit users are more likely to be employed full time. This is the same as the traditional hypothesis. Average household income has a positive effect on working status (β_8=0.036， Sig_8=0.016). Respondents from higher income households are more likely to be employed full time. Gender, property ownership and household size were not significant. In this regression model, two

crossover variables, commuting time * bus and other modes of travel and average household income * bus and other trip modes are not significant and maybe it is associated with the filtering of the samples (Table 11).

Table 11. The Regression Model of the Employment Status of Sample Data of Bus Travelers in Beijing

Variable	Unit	Coefficient	
		β	Sig
R^2	.113		
Constant		.255	.248
X_1 Commuting Time	min	Excluded	
X3 Commuting Time*Public Transit & Other Means of transportation	Crossover Variable	.000	.245
X4 Household Average Income* Public Transit & Other Means of transportation	Crossover Variable	Excluded	
X_5 Age	Year	.038	.002
X_6 Age*Age		-.001	.000
X_7Gender	Male=1 Female=2	-.031	.187
X_8 Family Population		.013	.263
X_9 Having Housing Property	Yes=1 No=0	.007	.807
X_{10} Household Average Income	Below2000=1 2000-5000=2 5001-10000=3 10001-20000=4 Above20000=5	.036	.016
Dependent			

Working Status	Full-time=1， Part time jobs/Unemployed=0		

None of the variables in the model predicting employment status for non-public transit users is significant. By stepwise regression, commuting time is excluded in this model.

Table 12. The Regression Model of the Job Status of Sample Data of Non-public travelers in Beijing

Variable	Unit	**Coefficient**	
		β	Sig
R^2	.061		
Constant		.202	.614
X_1 Commuting Time	min	Excluded	
Logarithmic explanatory			
X_5 Age	Year	.000	.572
X_6 Age*Age		.029	.162
X_7Gender	Male=1 Female=2	.000	.206
X_8 Family Population		-.075	.118
X_9 Having Housing	Yes=1	.012	.514
Property	No=0		
X_{10} Household Average Income	Below2000=1 2000-5000=2 5001-10000=3 10001-20000=4 Above20000=5	.042	.514
Dependent			
Working Status	Full-time=1， Part time job/ Unemployed=0		

The amount of variation explained in the regression model predicting job satisfaction for public-transit commuters is low and similar to the combined sample (R^2=0.063). Gender

(β_7=0.236，Sig_5=0.025) has a significant effect, indicating that women public-transit users experience higher job satisfaction than men. . Commuter time*public transit/other cross-variable shows a significant negative correlation, that is, as commute time for public-transit commuters decreases, job satisfaction increases (Table 13).

Table 13. The Job Satisfaction Regression Model of Public Transit Group in Beijing

Variable	Unit	Job Satisfaction Model	
		β	Sig
R^2	.063		
Constant		2.244	.002
Explanatory Variables			
X_1 Commuting Time	min	Excluded	
X_3 Commuting Time*Public Transit & Other Means of transportation	Crossover Variable	-.004	.011
X_4 Household Average Income* Public Transit & Other Means of transportation	Crossover Variable	Excluded	
X_5 Age	Year	-.008	.851
X_6 Age*Age	Year	.000	.816
X_7 Gender	Male=1 Female=2	.236	.025
X_8 Family Population	Person	.054	.176
X_9 Having Property Rights	Yes=1 No=0	-.027	.797
X_{10} Household Average Income	Below 2000=1 2000-5000=2 5001-10000=3	.079	.161

	10001-20000=4 Above 20000=5
Dependent Job Satisfaction	Very Satisfied =4， Satisfied=3， Neutral =2， Dissatisfied =1， Very Dissatisfied=0

Among non-public transit commuters, length of commute was also not significant in the model predicting job satisfaction for non-public transit commuters. Of the demographic variables in the model, but only age of respondent was significant, and it is positively associated with job satisfaction.

Through analysis with multiple regression, it found that commuting time and job satisfaction are positively correlated. if the commute time is longer, the job satisfaction will be higher, the mainly reason is, for the non-bus travel groups, the major means of transportation is car, it has higher flexibility, which means job satisfaction is also higher.

Table 14. The Job Satisfaction Regression Model of Non-Public Transit Group in Beijing

Variable	Unit	Job Satisfaction Model	
		β	Sig
R^2	.063		
Constant		2.244	.002
Explanatory Variables			
X_1 Commuting Time	min	.000	.913
X_5 Age	Year	.129	.069
X_6 Age*Age	Year	-.002	.057
X_7 Gender	Male=1 Female=2	-.109	.580
X_8 Family Population	Person	-.089	.285
X_9 Having Property Rights	Yes=1 No=0	.109	.655
X_{10} Household Average	Below 2000=1 2000-5000=2	.132	.212

Income	5001-10000=3 10001-20000=4 Above 20000=5
Dependent Job Satisfaction	Very Satisfied =4， Satisfied=3， Neutral =2， Dissatisfied =1， Very Dissatisfied=0

5 Conclusion

This study used survey data to examine the impact of transport infrastructure on the employment of low-income groups.

Apart from that the number of samples is relatively small, it also shows that the way that impacts employment status and employment satisfaction in Beijing metropolis area may be comprehensive and complex. The main findings of this study is as follows: 1) The regression analysis of employment status for all the samples shows that the older aged, male, and respondents living in households with higher incomes are more likely to be employed full time. 2) The model predicting job satisfaction shows that women have higher job satisfaction than men. Neither commuting time nor commuting mode was significant in either model. 3) In the population-specific regression analysis, the result suggests that for lower-income groups, younger respondents are more likely to be employed full-time and property owners have lower job satisfaction. 4) For those who use public transport to commute, younger people have higher proportion of full-time jobs and job satisfaction of women is higher, which is consistent with the overall sample regression results.

The results of these regression analyses show that, although time and mode of commute have a certain degree of influence on full-time employment and job satisfaction, these effects are not significant in most regression models. Relatively speaking, the degree of job success of specific groups in the labor market may be different comparing with the case of Urumqi.

The limitation of this study mainly lies in the small sample size. Comparing with the large scale of survey in Urumqi and Beijing, the small scale survey might not capture the whole picture of transportation on the low-income groups. Research on employment accessibility is worthy of further attention. In this study, it is found through small-scale surveys that in major cities of China with better infrastructure and sustainable development of rail transit, employment inequality is more prominent which is caused by difference of transport infrastructure investment. Enhancing job accessibility through land use planning and transportation policies should be a priority for city planners and policy makers.

Reference

China Statistic Year Book, China Statistic Bureau, 2016.

Gerhard L. Weinberg. A Century of Genocide: Utopias of Race and Nation. By Eric D. Weitz. Princeton, NJ: Princeton University Press, 2003. Pp. vii+360. $29.95.[J]. Journal of Modern History, 2005, 77(1):171-172.

Henry R, Lovett A, Sünnenberg G. Potential accessibility, travel time, and consumer choice: geographical variations in general medical practice registrations in Eastern England[J]. Environment and Planning A, 2003, 35(10): 1733-1750.

Hu L. Changing Job Access of the Poor: Effects of Spatial and Socioeconomic Transformations in Chicago, 1990-2010[J]. Urban Studies, 2014, 51(4):675-692.

Kawabata, M. (2003). Job access and employment among low-skilled autoless workers in US metropolitan areas. Environment and Planning A, 35(9), 1651–1668.

Long Y, Liu X, Zhou J, et al. Early birds, night owls, and tireless/recurring itinerants: An exploratory analysis of extreme transit behaviors in Beijing, China[J]. Computer Science, 2015, 57:223–232.

Wang E, Song J, Xu T. From “spatial bond” to “spatial mismatch”: An assessment of changing jobs–housing relationship in Beijing[J]. Habitat International, 2011, 35(2): 398-409.

Weitz J, Schindler T. Are Oregon’s communities balanced? A test of the jobs-housing balance policy and the impact of balance on mean commute times[J]. Unpublished manuscript. Department of Urban Studies and Planning, Portland State University, 1997.

Zhang C, Man J. Examining Job Accessibility of the Urban Poor by Urban Metro and Bus: A Case Study of Beijing[J]. Urban Rail Transit, 2015, 1(4):183-193.

Zhao, P. and B. Lu (2010). Exploring job accessibility in the transformation context: an institution a list approach and its application in Beijing[J]. Journal of Transport Geography 18: 393–401.

龙瀛,茅明睿,毛其智等.大数据时代的精细化城市模拟:方法,数据和案例[J].人文地理,2014,29(3):7-13.

易成栋,张纯.北京失业人口的空间分布及其影响因素[J].中国人口科学, 2015(6):2-11.

张纯,易成栋,宋彦.北京市职住空间关系特征及变化研究——基于第五、六次人口普查和 2001、2008 年经济普查数据的实证分析[J]. 城市规划, 2016, 40(10):59-64.

刘志林,王茂军.北京市职住空间错位对居民通勤行为的影响分析——基于就业可达性与通勤时间的讨论[J]. 地理学报, 2011, 66(4):457-467.