Impact of Transportation on the Employment of Low-Income Groups - Case Study of Urumqi

Beijing Jiaotong University

2017

The publication of this study has been made possible through a grant from the Jobs Umbrella Trust Fund, which is supported by the Department for International Development/UK AID, and the Governments of Norway, Germany, Austria, the Austrian Development Agency, and the Swedish International Development Cooperation Agency.

Contents

The publication of this study has been made possible through a grant from the Jobs Umbrella Trust Fund, which is supported by the Department for International Development/UK AID, and the Governments of Norway, Germany, Austria, the Austrian Development Agency, and the Swedish International Development Cooperation Agency.

Impact of Transportation on the Employment of Low-Income Groups - Case Study of Urumqi

1 Introduction

As the urbanization rate of cities around the world is projected to increase rapidly in the 21st century, transportation infrastructure construction becomes ever more important for urban health and sustainable development. Urban planners and transportation planners alike hope to increase regional and urban economic growth, ease traffic congestion and improve urban traffic efficiency by increasing investment in transportation infrastructure. Transport infrastructure is important for cities not only at the technical level, but it can also improve employment levels by providing a better connection between housing and employment centers. In particular, for low-income groups transportation infrastructure plays an important role in reducing unemployment, improving employment opportunities and overall quality of life.

A review of existing literature reveals that transportation infrastructure plays a key role in employment accessibility in two aspects. First, as a direct economic impact, the cost of transportation can become a significant part of total household expenditure, which places a burden on low-income families (Henry and Goldstein, 2010); secondly, infrastructure development, especially public transport infrastructure, can significantly improve the urban residential space relationship, thereby enhancing employment accessibility of disadvantaged groups, as well as local equity (Blumenberg and Ong, 1998; Holzer, 1991). As more research is focused on the issue of employment accessibility, special attention has been given to city job housing spatial relationship, which also has a fundamental influence on a city's overall level of employment and solving the insufficient supply of traffic. However, if urban congestion is a result of poorly planned and designed infrastructure, traffic flow optimization measures will only have a limited impact and cannot be itself solve the problem. Therefore, this paper focuses on how residential location influences employment levels and employment accessibility of low-income groups.

So far, the main body of research and case studies have focused on the measurement of employment accessibility, the relationship between job location and transportation infrastructure. These studies have shown that, on the basis of the established patterns of city space, the availability of public transport facilities has an important effect on the participation rate of the labor market, which shows that good public transport facilities enable a higher level of employment (Baum, 2010; Kawabata, 2003). For example, studies have highlighted that the availability of private cars increases access to employment opportunities and enhances the scope of choice and flexibility in the job market (Taylor and Ong, 1995). Moreover, other studies found that variations in traffic patterns can lead to significant differences in employment accessibility (Shen, 2001; Zhang and Man, 2015). Recently, it has been noted that spatial dislocation of jobs and housing has become more complex under new trends such as continuing suburbanization, multi-centric development (Hu, 2015). While the importance of distance itself decreases, the availability of different public transport services becomes a more crucial factor.

Besides developed countries, the impact of transportation infrastructure on the employment of low-income groups has gradually gained more attention in the rapidly developing cities of China. Job-housing spatial mismatch began with the disintegration of traditional units in 1990s, as well as with rapid suburbanization. In particular, new urban affordable housing is mostly located at the outskirts of cities, while main employment hubs remain concentrated in city centers (Zhang, Yi and Song 2016). At the same time, whether in the city or in suburban areas, the development of urban transportation is uneven, which can deprive low-income groups of employment opportunities. In this sense, the impact of transport infrastructure on the city is not only limited to the technical level, but also has a more far-reaching social and economic impact.

Based on the background analysis and previous literature, this paper is a case study of the capital of the Xinjiang Province in western China, Urumqi. It explores how employment accessibility, job-housing spatial relations, and transport infrastructure, influence the employment levels in the city. Especially, it focuses on the influence of public traffic infrastructure on the employment status and job satisfaction of low-income groups.

Urumqi is a traditional industrial city with a large population of ethnic minorities, where public transport facilities are less developed compared to cities in the east of China. It is assumed that the city's underdeveloped public transport hinders access to employment among citizens. Therefore, the study of the impact of transportation infrastructure is not only conducive to improving the employment accessibility of low-income groups.

2 Literature Review

2.1 Measuring Employment Accessibility

The concept of reachability can be traced back to the definition proposed by Hansen in 1959, who defined it as the potential interaction in space (Hansen, 1959). However, the definition of accessibility varies with differences in research perspectives. The definition recognized in the field of traffic engineering is the degree of difficulty to get somewhere in the particular traffic system (David and Martin, 1976). But in geography perspective, it is defined as an effective opportunity for people to reach their location, emphasizing human activities; it is more concerned with the degree of convenience for a person or group to arrive at a destination or to participate in a particular activity, which is determined by land use and transportation systems (Geurs, 2006). Essentially, the common point of these accessibility concepts is to characterize the ease of arrival to one location from another.

Among the multiple accessibility issues, job accessibility highlights the level of accessibility to people seeking for employment opportunities. In particular, the ease with which a certain level of resistance can be overcome from the place of residence to the place of employment; this also underlines the impact of changes in transport mode on employment (Wachs and Kumagai, 1973; Handy and Niemeier 1997). In metropolitan areas, employment accessibility is affected by the combined effect of job-housing relations and transport infrastructure. In a sense, the imbalance of employment location and residence location must mean a low level of employment accessibility, while the spatial relationship between job and living spaces does not necessarily mean a high level of employment accessibility. Therefore, the relationship between job and housing is not an accurate measure of employment accessibility. Considering how public transport infrastructure can act as an important bridge linking the place of residence to the place of employment, direct measurement of employment accessibility will better reflect the characteristics of cross-commuting and its relation to transport infrastructure.

The level of employment accessibility has more far-reaching social impacts for low-income groups, in addition to the impact of transport. For example, traditionally studies of employment accessibility have focused on low-skilled workers residing in urban inner-city areas and looking for access to suitable employment opportunities (Kain, 1968; Stoll, 2005, 2006). With rapid suburbanization since the end of the twentieth century, the place of residence which low-income groups concentrated in, as well as job sites suitable for low-income groups are relocated. With rapid suburbanization, the problem of low employment accessibility of low-income groups is not disappeared, but presents a more complex situation (Hu, 2015). With increased suburbanization, employment accessibility of low-income groups is more dependent on local transport facilities, especially public transport facilities (Abramson et al., 1995; Jargowsky, 1996; Haynes, et al, 2003). Moreover, with suburbanization, low-income groups are exposed to greater employment pressure and commuting costs, insufficient exchange of information, which consequently increases the importance of providing adequate public transport services to offset the negative impacts of suburbanization. These studies suggest that better public transport conditions are conducive to enhancing employment accessibility of low-income groups.

2.2 Urban Job-Housing Spatial Relationship

The relationship between job and residence, employment accessibility and traffic infrastructure are closely related and the relationship between them become an important entry point for the study of urban transportation problems.

From a perspective of urban society and equity, the costs of commuting will affect household expenditure, and the spatial relationship between job and housing is not only directly determines the degree of urban traffic, but also indirectly affect the quality of life of urban residents (Blumenberg and Ong, 1998). After John Kain proposed the assumption that the suburbanization of the United States brought about a job imbalance in the 1960s, studies from the early 21st century found that although a suburbanization of employment was occurring in large American cities between job and housing became more prominent. The suburbanization of jobs does not mean that all jobs are evenly distributed in the suburbs, but only in a few employment centers (Giuliano and Small, 1991), which in fact means that the employment gap of the affluent and the poor also widened in the process of suburbanization.

Scholars usually believe that the ideal relationship between job and housing are perfectly balance. However, both in the West and Chinese cities, people face increasing time and economic costs of long-distance commuting, and traffic jams grow more serious. For example in Beijing, the average one-way commuting time reached 43 minutes in 2009 (Zheng and Cao, 2009), it increased again by about 10min by 2011 (National Bureau of Statistics, 2010).

In fact, the average one-way commute in Chinese cities is much longer than that in the United States (38.3 minutes, longest in Philadelphia) and in Europe (22.5 minutes, longest in UK) (US Census Bureau, 2005; King and Leibling, 2003). The United States has also tried to implement some planning and transport policies to reinvigorate the balance of occupations, such as bringing jobs back to the inner city or promoting commuting, and so on (Blumenberg and Pierce, 2014; Chapple, 2006). However, according to the results of the US traffic survey, in fact since the 1970s, the average commute distance has not shortened but increased by one third. In the Atlanta metropolitan area, for example, the average daily Vehicle Travel Miles (VMT) per person increased from 19.8 miles in 1982 to 35.1 miles in 1999 (Weitz, Jerry, and Schindler 1997).

2.3 Public Transport Infrastructure and Its Impact

Scholars of urban transport also discuss the accessibility of employment and the assumption of misplaced employment. Case studies from Los Angeles, San Francisco, and Boston concluded that it is not the geographical distance itself, but the influence of the choice of modes of transport that places disadvantaged groups in unfavorable situations (Shen, 2000; Kawabata, 2003; Hu, 2015). It has also been found that car ownership is crucial for increased flexibility in approaching employment opportunities, especially for low-skilled workers with variable working hours (Taylor and Ong, 1995).

It is generally assumed that increasing urban public transport infrastructures can improve urban employment and ease of travel, and mitigate urban imbalances in terms of job relations and limited employment accessibility.

For example, empirical studies in Europe have shown that transport infrastructure is an important constraint on the economic competitiveness of economically backward regions (European Commission, 2004). As a result, the continuous improvement of public transport infrastructure not only facilitates local employment but is also a key factor in reducing regional economic disparities (Holl et al, 2004). Another study found that public transport infrastructure and employment, economic development, social welfare and environment impact on each other closely. For example, Dalenberg's study of panel data from 1972 to 1991 of the 48 states of the United States showed that the construction of freeways had a significant positive effect on labor employment in the states (Dalenberg et al., 1998).

In addition, there are studies that examine the short-term and long-term effects of public transport infrastructure on employment. For example, national studies in German suggest that regional infrastructure inputs account for regional differences in employment growth (Laird, Nellthorp and Mackie, 2005). A study by Demetriades and Mamuneas (2000) based on 12 OECD countries showed that transport infrastructure investment had a clear long-term positive effect; but the study also found that the short-term return on transport infrastructure was significantly lower than the long-term, which also reflected the lack of long-term supply of public transport infrastructure. Thus, seeking a balance between short-term and long-term infrastructural inputs is a matter for policymakers to improve access to employment.

3 Method, Case Study and Data Collection

3.1 Method

Furthermore, it examines the impact of these factors on job satisfaction and employment status by adding these variables to the regression model, and then evaluate the impact of transportation infrastructure investment on the employment success of the low-income groups. Both linear regression model and multinomial logit model are used.

In the Urumqi travel survey in 2014, the main information includes commuting time, travel mode, private car ownership, and the distance to the nearest BRT site. We also include data on age, gender, income and other individual attributes. In addition, the satisfaction degree of the job and the employment status are used as dependent variables to measure the degree of employment success. The independent variables, such as commuting time, commuting distance, are combined with the individual attributes for cross-variables.

In the model, commuting time (X_1), commuting mode (X_2), commuting time * commuter bus travel mode (X_3), income * public travel mode (X_4), respondents age (X_5), square of the respondents' age（X_6）、gender（X_7）、family population（X_8）、whether property（X_9）、 average monthly household income（X_{10}）and the distance from the nearest bus station in the distance (X_{11}) are the independent variables, and working state (Y_1) and job satisfaction (Y_2) are the dependent variables in the multiple linear regression model Logit. The regression models were (Table 1):

$$\text{Logit}(Y_1) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} \quad (1)$$

and

$$\text{Logit}(Y_2) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} \quad (2)$$

Table1. Variable Description in regression model

Variable	Explanation for variable	Unit
independent variable: traffic		
Commuting time X_1	One-way commuting time to work	Minute
Commuting mode X_2	The transportation mode for work (car / bus and so on)	Categorical variable
Commuting time * Commuter bus Travel mode X_3	One-way commuting time to work*Use of non car travel	Categorical variable
Income * Public travel mode X_4	Income level*Use of non-car travel	Categorical variable
Respondents age X_5	The age of the respondents	Year
Square of the age X_6	Age*age	Year

Respondents gender X_7	The gender of the respondents (male / female)	Categorical variable
Family population X_8	How many people are there in the respondents' family?	Person
Property ownership X_9	Property ownership or not (yes / no)	Categorical variable
The average monthly Income X_{10}	Average monthly income of the family (2000 below; 2000-5000 yuan; 5001-10000 yuan; 10001-20000 yuan; more than 20000)	Categorical variable
The distance from the nearest bus Station in the distance X_{11}	Distance from the nearest bus station	Meter
Dependent variable		
Employment status Y1	Full time / part time, no work	Categorical variable
Job satisfaction Y2	Very satisfied / satisfied / general / dissatisfied / very dissatisfied	Categorical variable

3.2 Case Study of Urumqi - Public Transport Facilities and BRT Lines

Urumqi as the capital of Xinjiang, an important western city on the Silk Road, is not only a hub of highways, railways and aviation in Xinjiang, but also one of the four major gateways to China and the outside world, especially the five Central Asian countries. Urumqi city has jurisdiction over seven districts and one county, covering an area of 13787.6 square km^2.

According to data from the comprehensive transportation system plan of Urumqi (2010-2020), the daily travel frequency per capita is about 2.47 times, the average travel time is 32.2 minutes, and the morning and evening peak is obvious, the proportion of public transportation is 30.25%.

Therefore, the study of the impact of transport infrastructure investment is not only conducive to improving the employment of low-income groups accessibility, but also conducive to enhancing the employment of ethnic minorities accessibility. Based on previous research and literature, this paper aims to study the impact of transportation factors on urban employment, such as employment accessibility and the job-housing spatial relationship. It is especially concerned with the impact of facility investment for the low-income groups on the labor market.

The population of Urumqi reached 3,53 million in 2014. In terms of public transport, Urumqi has seen many new developments in recent years, including conventional buses, BRT-lines, and rail transit. Among them, there have been 157 bus lines and 4567 of bus stop till 2014.

In addition to conventional buses, Urumqi has built 7 BRT lines covering the main part of the city center (Figure 1). Urumqi city was one of 15 public transportation construction demonstration projects in China. In the near future, the plan is to build seven subway lines to improve the coverage of the city's rail transit network.

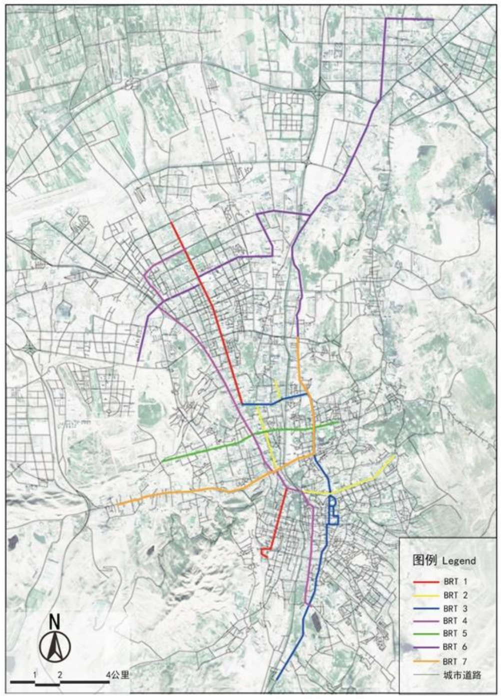


Figure 1. Spatial Layout of 7 BRT lines in Urumqi

The level of public transport development in Urumqi is lagging compared with other Chinese cities. Although there has been significant public transport investments, transportation-related poverty and employment difficulties seem to persist in Urumqi, compared with cities in eastern China. Urumqi's bus network density (1.6km / km^2 in 2014) is still below the average level despite the large amount of public transport investment.

3.3 Population and Employment Spatial Distribution

The distribution of population and employment density in Urumqi, based on TAZ data from 2014, can be used to highlight the job-housing spatial relationship of Urumqi. The main residential centers are still located in the city center, and population density decreases with distance from the urban core. Apart from the Northeast in Midong District, no population center was formed. (Figure 2 left).

The employment density analysis of TAZ units shows that job opportunities are still concentrated in urban centers, and the spatial distribution of jobs is more decentralized than the population distribution, which is concentrated in the urban core. This may be related to the spatial distribution of industry and manufacturing in Urumqi (Figure 2 right).

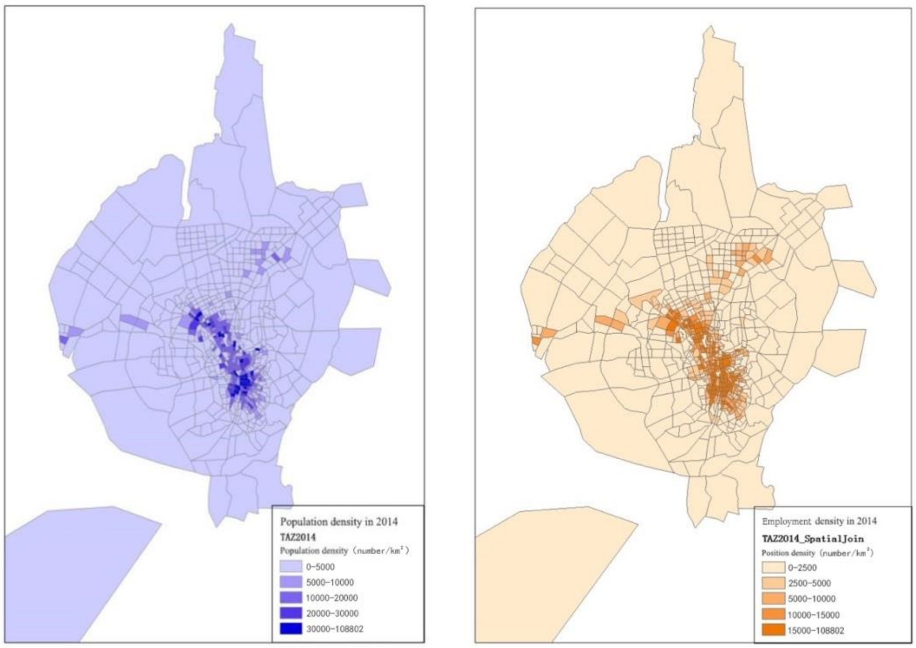


Figure 2. Distribution of population density (left) and employment density (right) in Urumqi in 2014

In order to analyze the employment accessibility of low-income populations, it is necessary to pay attention to the spatial distribution of low-income communities. According to the demographic data of sub-districts and towns in 2010, it is possible to identify potential low-income industries, ethnic minority areas, and non-residence population clusters (densities exceeding one standard deviation) in urban areas and to conduct cross-analysis. The data shows that, according to the employment sector, potential low-income industries such as mining, construction, manufacturing, etc. are mostly distributed in the northern suburbs of the city. A high proportion of the floating population is concentrated in the suburbs, especially in the northeast, northwest and south. A cross-analysis of these factors showed that potential low-income communities with ethnic minority and migrant residents were more likely to be located in suburban areas, especially in the north and southeast regions (Figure 3).

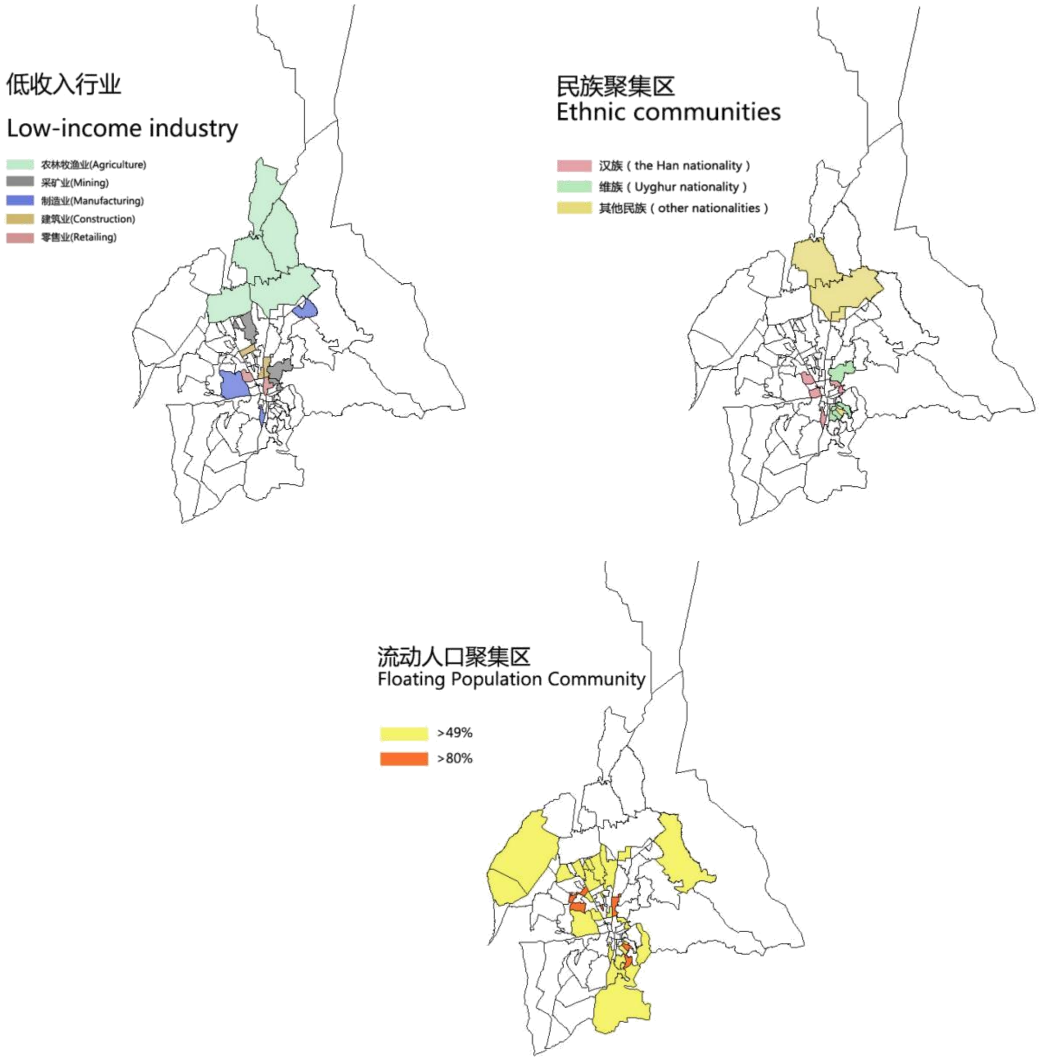


Figure 3. Analysis of potential low-income communities based on industry, race and floating population in Urumqi

3.4 Job-housing Ratio Changes along BRT Lines

In addition to using the Urumqi traffic survey data, the study also uses the 2010 and 2014 population and employment data to examine whether the JHB index along the BRT varies with the impact of the new transport infrastructure. According to the theory of the spatial relationship between occupations, traffic infrastructure construction can help improve the spatial relationship between job and housing, to enhance employment accessibility within the whole urban space.

Taking TAZ as the basic unit, this paper investigates the JHB index changes along BRT lines from 2010 to 2014. Overall trends indicated that the increase in JHB index along the BRT reflected the fact that the BRT system would bring more job opportunities to those people who were limited by time and travel costs along the route, and the savings in travel time and costs would allow them to have more opportunities to reach more people and enable better job opportunities.

After the completion of the BRT, the job-housing ration of BRT lines intensive areas has been significantly improved, such as the streets of Zhongya South Road, Shiyouxincun streets, Youhao South Street, Hetian Street. However, the BRT line coverage of lower density areas have declined, such as the northeast of the Kaziwan Street, Dibang streets and Gumudi town.

Specifically, the Shiyouxincun streets is a typical case along the BRT line whose ratio has improved. Wholesale and retail trade, transportation and postal services were the main industries in the region, and the street itself was a commodity trading center and a regional economic center, so the convenience of public transport attracted more people to come for business and employment.

In contrast, the typical case of a decrease of JHB index may be divided into two kinds: the first example is Gumudi town, where agriculture, forestry, animal husbandry and fishery were the most important industry types. The impact of public transport development on these industries was marginal. Another example is Kaziwan Streets, where the residents were mostly engaged in manufacturing and construction. Most workplaces were concentrated in the center of the city area and the completion of the BRT made it easier for residents to move from their places of residence to workplaces so that the proportion of residents going out to work increased, leading to a decline of the ratio in this area.

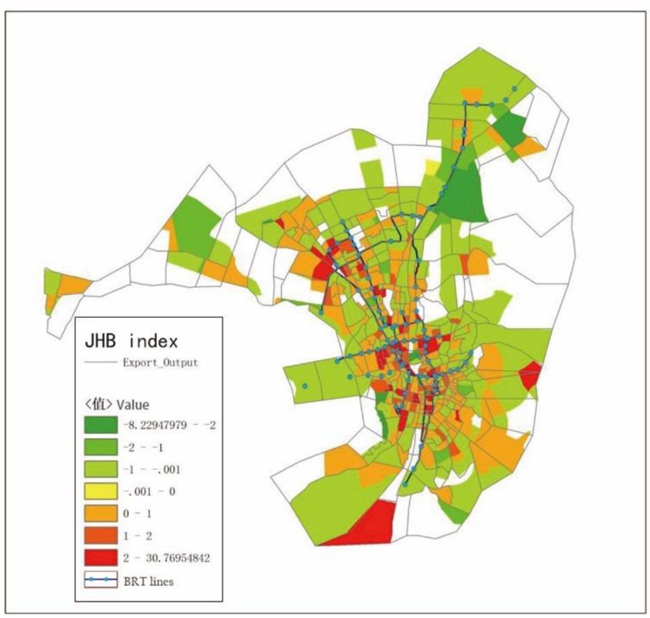


Figure 4. the change of JHB ratio along BRT in Urumqi city from 2010 to 2014

Figure 4 showed that, the overlap of the BRT line and ethnic minority areas only occurred at the end of the BRT line. As a result, BRT construction had little impact on the concentration of ethnic minorities compared to urban centers because BRT lines in ethnic minority enclaves were not dense.

3.5 Sources of Trip Survey and Data Collection

The survey data consists of a travel behavior survey in Urumqi. It used the 2010 standard trip questionnaire, and the survey is done in 2014. In the questionnaire, there are three level of data, family level, individual level and trip level. Each of the level ask questions like:

(1) Family level: name of neighborhood, address of neighborhood, family income, family size, car ownership.

(2) Individual level: age, gender, occupation type, employment status and job satisfaction. Here are two variables on employment status: work status, work details status. It also asked the length from work place or school to the nearest bus stop.

(3) Trip Level: most of the commuting factors are in these level, including travel mode, commuting time, number of trips, departure time and arrival time, cost.

A total of 58,809 valid questionnaires were collected, in which 25070 families were represented. The smallest research unit in this study was individual trips. And altogether 134073 trips are collected (Figure 5). The regression model of this study will be mainly derived from the analysis of survey data.

In order to establish data set, this study select individual as basic statistic unit. It joins family level information to individual level, such us household average income, address of neighborhood. Due to the vacancy of distance related variables, it calculates the point to point distance from housing to employment location by their address in GIS for each individual. Also, it calculated the distance to the nearest BRT bus stops by point to point distance from residential neighborhood center by GIS for each individual. Because commuting mode and commuting time are on trip level, it selects the first trip and trip purpose is “go to work” as their valid trip for each individual.

样本类型： 1 随机样本
2 追加样本

表　　号：
制表机关：
批准机关：
批准文号：
有效期至：

2010年乌鲁木齐居民出行调查问卷

（封面）

（本页由调查员在入户当天填写）

> 尊敬的先生/女士：
> 您好！我是2010年乌鲁木齐市居民出行调查的调查员，我们正在进行全市居民一日出行调查，需要了解您和您的家人在一天中的出行情况。这次调查的数据将被用于乌鲁木齐市轨道交通建设规划，您所提供的资料不会被透露给任何第三方或用于其它目的，谢谢您的支持与合作！
> 乌鲁木齐2010年居民出行调查领导小组
> 2010年8月

入户预约日期： 2010年____ 月____ 日

调 查 日 期： 2010年____ 月____ 日

调查员姓名： ____________ 调查员编号：☐☐☐ 调查员工作电话：____________

督导员姓名： ____________ 督导员工作电话： ____________

电话回访员姓名：____________ 电话回访员工作电话____________

住户详细地址： 乌鲁木齐市 ____________ 区（县） ____________路（街、乡） ____________ 号

____________院（小区）____号楼 ______单元 ______ 号

行政区编码:☐☐ 社区编码:☐☐☐ 交通小区编号:☐☐☐ 抽样住户序号:☐☐☐☐☐

入户调查情况： ☐☐

01 成功入户 02 无应答 03 拒访 04 空屋 05 非居住 06 地址缺失

表　　号：
制表机关：
批准机关：
批准文号：
有效期至：

2010年乌鲁木齐居民出行调查问卷

（个人信息）

（本页由受访人在入户当天填写或由调查员协助填写）

交通小区编号: ☐☐☐ 抽样住户编号: ☐☐☐☐☐ 受访人姓名： ______ 受访人编号: ☐☐

个人信息

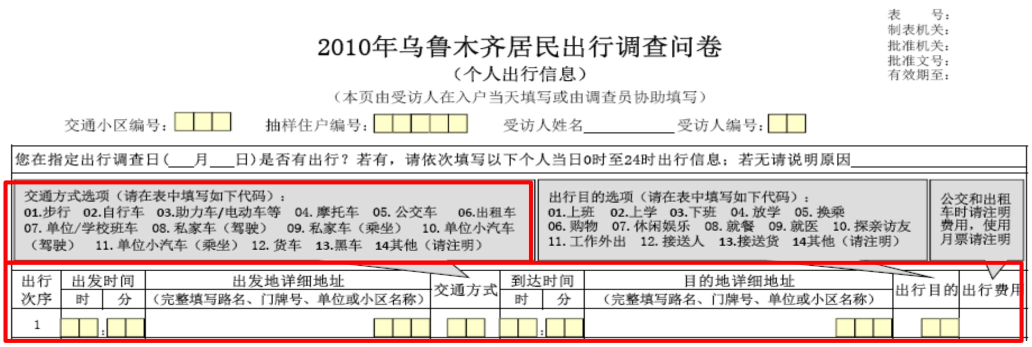
Q1 性别	Q2 年龄	Q3 居住状态	Q4 就业/就学状态	Q5 工作单位/就读学校地址
01 男 02 女 ☐☐	______周岁 ☐☐	01 常住 02 临时居住 ☐☐	01 工作 02 就学 03 待业 04 离退休 ☐☐	________区（县）________路（街、乡） ________号（若地址不易确认，请填参照建筑物名 ______________________ ☐☐

Q6 工作性质 如果Q4选“工作”时回答本问题	Q7 工作单位/就读学校距离最近的公交站的步行时间	Q8 持有的公交卡类型
01 工人　02 科技人员　03 公司职员 04 公务员　05 医护人员　06 教育工作者 07 服务业人员　08 个体/私营户　09 事业单位人员 10 自由职业者　11 军人/警察　12 专职司机(除公交、出租车司机外) 13 公司企业管理者　14 农民 ☐☐	01 少于3分钟　02 3至5分钟 03 5至10分钟　04 10至15分钟 05 15至20分钟　06 大于20分钟 ☐☐	01 无公交卡　02 普通成人卡 03 学生卡　04 老人卡 05 员工卡　06区内成人月票 07 区内学生月票 08 郊区成人月票 09 郊区学生月票 ☐☐

个人意愿

Q2 您认为合理的轨道交通单次出行费用上限是	Q2 您认为合理的轨道交通班次间隔时间上限是
01 一元　02 两元 03 三元　04 三元以上 ☐☐	01 一至三分钟　02 三至五分钟 03 五至十分钟　04 十分钟以上 ☐☐

全户所有6岁以上（含6岁）成员独立填写一份，包括指定出行调查日在本户居住的临时居住人口在内



2010年乌鲁木齐居民出行调查问卷

（个人出行信息）

（本页由受访人在入户当天填写或由调查员协助填写）

表　　号：
制表机关：
批准机关：
批准文号：
有效期至：

交通小区编号：　抽样住户编号：　受访人姓名＿＿＿＿＿受访人编号：

您在指定出行调查日（＿＿月＿＿日）是否有出行？若有，请依次填写以下个人当日0时至24时出行信息；若无请说明原因＿＿＿＿

交通方式选项（请在表中填写如下代码）：
01.步行　02.自行车　03.助力车/电动车等　04. 摩托车　05. 公交车　06.出租车　07. 单位/学校班车　08. 私家车（驾驶）　09. 私家车（乘坐）　10. 单位小汽车（驾驶）　11. 单位小汽车（乘坐）　12. 货车　13.黑车　14其他（请注明）

出行目的选项（请在表中填写如下代码）：
01.上班　02.上学　03.下班　04. 放学　05. 换乘　06. 购物　07. 休闲娱乐　08. 就餐　09. 就医　10. 探亲访友　11. 工作外出　12. 接送人　13.接送货　14其他（请注明）

公交和出租车时请注明费用，使用月票请注明

出行次序	出发时间		出发地详细地址	交通方式	到达时间		目的地详细地址	出行目的	出行费用
	时	分	（完整填写路名、门牌号、单位或小区名称）		时	分	（完整填写路名、门牌号、单位或小区名称）		
1									

Figure 5. Structure Questionnaire in Urumqi residents travel questionnaire

4 Regression Analysis Results and Discussion

4.1 Basic Characteristics of Urumqi Trip Survey

First of all, the basic information of Urumqi trip survey samples are analyzed. When setting variables, the variables such as commuting mode, sex of interviewees, ownership of housing property, family average monthly income, employment status and job satisfaction are categorical variables, and commuting time, age and gender are single variables. By sorting the basic properties of the sample survey, initial results show that the average commuting time of residents in Urumqi was 33 minutes and about 79.9% of the residents chose public transportation as the first choice, while only 20.01% of the residents used private cars. Hence, public transport is a widely accepted transportation mode in Urumqi. Furthermore, the average age of respondents was 39.6 years old, and 89.65% of the surveyed people own their property. In terms of income, 72.9% of residents had a monthly average income between 2000-5000 yuan, while 7.79% of residents earned less than 2,000 yuan. The remaining 19.37% of residents earned between 5000-10000 yuan per month.

According to work status reports, 97.43% have full-time job while 2.57% have fart-part or no job. In the samples, 61.73% of the residents reported satisfaction with their job situation (responded either “very satisfied”, “satisfied”, or “general satisfaction”). 1.66% of residents claimed to be not satisfied or very dissatisfied with their job situation (Table 2).

Table 2. Basic information of the sample in the survey

Option	Unit	Sample number	Average or (%)	standard deviation
Commuting time	min	35995	33	26.64
Commuting	Car	7229	20.07%	/

mode	Bus or other	28766	79.93%	/
Age	Year	35995	39.6	9.4
	Male	19501	54.19%	/
Sex	Female	16494	45.81%	/
Whether to have	Yes	32272	89.65%	/
housing property rights	No	3723	10.35%	/
	Below 2000 yuan	2782	7.73%	/
Average	2000-5000yuan	26240	72.9%	/
monthly	5001-10000yuan	6973	19.37%	/
household	10001-20000yuan	/	/	/
income	More than 20000	/	/	/
Distance to the nearest bus station	m	35995	3033	5044
Job-housing distance	m	32325	3890.80	4671.25
Work status	full-time	35070	97.43%	/
	part-time/no job	925	2.57%	/
	Very satisfied	8691	24.14%	/
	Satisfied	15306	42.52%	/
	commonly	11406	31.68%	/
	Dissatisfied	500	1.39%	/
Job satisfaction	Very dissatisfied	92	0.27%	/

4.2 Impact Factors on Job accessibility

Usually, the job-housing spatial relationship reflects the whole spatial pattern of city functions, but because the relationship does not accurately consider employment accessibility, it can be problematic to use the job-housing spatial relationship to analyze the impact of public transportation infrastructure on employment. However, job accessibility can directly reflect the degree of job-housing imbalances, and readily measure the employment accessibility level, as well as highlight the effect of transport infrastructure on employment rates.

In this study, taking the commuting time as measurement of job accessibility, regression analysis showed that the impacts of X_1 Commuting Mode (β =-43.110, Sig=0.000), X_2 commuting time *bus / other travel modes (β=3.351, Sig=0.000) on job accessibility are very significant. In personal attributes, X_6 gender (β=-.415, Sig=0.000), X_7 family population (β=1.104, Sig=0.000) and X_{10} Household Average Income (β=-43.110, Sig=0.000) are significant. In terms of personal attribute, it shows that the females have worse job accessibility comparing to males. These findings are consistent with earlier hypotheses or research results, indicating that more means of transportation enhances employment possibility, which means more convenient and better job accessibility (Table 3).

Table 3. Job Accessibility Regression Model of Urumqi

Job Accessibility	Unit	B	Sig.
Constant		43.741	.000
X_1 Commuting Mode	Public Transit & Other Means of transportation=1， Cars=0	-43.110	.000
X_2 Commuting Time*Public Transit & Other Means of transportation	Crossover Variable	3.351	.000
X_3 Household Average Income* Public Transit & Other Means of transportation	Crossover Variable	.999	.000
X_4 Age	Year	-.054	.331
X_5 Age*Age	Year	.001	.342
X_6 Gender	Male =1 Female =2	-.415	.005
X_7 Family Population	Person	1.104	.000
X_8 Having Property Rights	Yes=1 No=0	.248	.530
X_9 Employment Status	Full-time=1， Part Time Jobs and Unemployment=0	-3.427	.000
X_{10} Household Average Income	Below 2000 =1 2000-5000=2 5001-10000=3 10001-20000=4 20000 and up=5	-43.110	.000

4.3 Impact Factors on Employment Status and Job Satisfaction

Here we examine the impacts of personal attributes and transportation factors on the employment status, as well as job satisfaction of the residents by the gradual addition of variables in a regression model.

Based on the above analysis, we take the variables commuting time (X_1), travel mode (X_2), commuting time * public travel mode (X_3), public transportation income * (X_4), respondents age (X5), square of the respondents' age（X_6）、gender（X_7）、family population（X_8）、whether property（X_9）、average monthly household income（X_{10}）and the distance from the nearest bus station (X_{11}) as independent variables, and the investigation on the working condition of residents and residents satisfaction as the dependent variables for regression analysis.

(1) Regression model of employment status

A model is designed in order to examine the influence of the dependent variables on the employment status of the residents.

$$\text{Logit}(Y_1) = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11}$$

The regression model showed that adjust R^2 is 0.66. Effects of the commuting time (X_1) was not significant, while travel mode (X_2) was significant. Respondents taking a private car for their commute had a higher full-time employment rate. Among the designed cross variables, the average household income*bus and other modes of travel (X_3) were not significant, and the commuting time*bus and other modes of travel (X_4) showed significant characteristics.

The influence of factors showed significant relevance in some cases, namely gender (X_7) for men, the higher the likelihood of full-time employment (β =-0.014, Sig=0.000). There was a greater likelihood of property owners (X_9) (β =0.21, Sig=0.035), which was not consistent with the traditional theory and may be due to property ownership account for only 11% and their full-time employment rate was higher. And the higher average household income (X_{10}) of the family, the higher the likelihood of full time employment (β =0.008, Sig_8=0.000), which was the same as the traditional theoretical hypothesis.

In terms of the distance factors, the distance from the nearest bus station (X_{11}) showed no significant impact on probability of full-time employment. In general, the rate of use of public transport by most residents of Urumqi was higher than other Chinese cities, and the distance from the public transport station to the place of residence does affect the employment status of residents.

Table 4. The regression model of the employment status of the respondents in Urumqi

Variable	Unit	Working status model	
		β	Sig
R2	.066		
Durbin-Watson	1.403		
Constant		.607	.000
Explanatory variables			
X_1 commuting time	min	4.025E-005	.568
X_2 commuting mode	Bus and other=1，Car=0	-.028	.011
X_3 average Monthly Income*bus and other	Cross variable	.009	.050
X_4 commuting time*bus and other	Cross variable	-2.253E-005	.784
X_5 age	Year	.024	.000
X_6 square of the age	Year	.000	.000
X_7 gender	Male=1 Female=2	-.014	.000
X_8 family population	Person	-.010	.000
X_9 property ownership	Yes=1 No=0	.021	.000
X_{10} Average household income	Below 2000=1 2000-5000=2 5001-10000=3 10001-20000=4 More than 20000=5	.008	.040
X_{11} distance to the nearest BRT bus station	Meter	-.001	.481
Dependent variable			
Employment status	Full-time=1，Others=0		

(2) Regression of job satisfaction

The adjust R^2 in this regression model is 0.028. In the transport factors affecting job satisfaction, travel mode showed a significant effect, with high work satisfaction among those respondents who travel by car to work. For cross variables, the average household income * bus, other means of travel (X_3) showed significant characteristics, while commuting time * bus and other travel modes (X_4) showed a significant effect, that was, the higher the average monthly income of people choosing to travel by bus, the lower the job satisfaction. The longer the commute time, the higher the satisfaction of the work.

The impact of individual attributes is consistent with the traditional theoretical assumptions. Regression results indicated that the younger the respondents were, the higher the satisfaction with the job. Gender factor is not significant on the job satisfaction. The more of family number, the higher the satisfaction of the work. The higher the household average income (X_{10}), the higher the job satisfaction (β = 0.217, Sig= 0.000). Property ownership also has positive impact on job satisfaction(β = 0.217, Sig= 0.000).

From the distance factors, the distance from the nearest BRT bus station (X_{11}) showed a negative correlation（β =-0.043，Sig=0.000） which indicates that the closer to BRT have higher satisfaction of the job. It suggests that the use of public transport is an important factor when commuting to work in Urumqi.

Table 5. The regression model of overall job satisfaction in Urumqi

Variable	Unit	Job Satisfaction Model	
		β	Sig
R^2	.028		
Durbin-Watson	.864		
Constant		2.772	.000
Explanatory variables			
X_1 commuting time	min	-5.658E-005	.852
X_2 commuting mode	Bus and other=1，Car=0	.028	.552
X_3 average family income*bus and other	Cross variable	-.065	.001

X_4 commuting time*bus and other	Cross variable	-.001	.000
X_5 age	Year	-.004	.166
X_6 square of the age	Year	4.402E-005	.262
X_7 gender	Male=1 Female=2	-.008	.341
X_8 family population	Person	-.032	.000
X_9 property ownership	Yes=1 No=0	.123	.000
X_{10} average household income	Below 2000=1 2000-5000=2 5001-10000=3 10001-20000=4 More than 20000=5	.217	.000
X_{11} distance to nearest BRT bus station	Meter	-.043	.000
Dependent variable			
Employment satisfaction	Very satisfied=4， Satisfied=3， Commonly=2 ， Dissatisfied=1， Very dissatisfied=0		

Through multinomial logit model analysis, it finds that in the traffic factors, the impact of commuting time and nearest distance to BRT stop have more significant impact on some job satisfaction level. Most of the results are consistent with the results of the linear regression.

Table 6. The multinomial logit model of overall job satisfaction in Urumqi

	Job Satisfaction Model	**Unit**	**B**	**Sig.**
Y=0	Constant		-4.108	.021
	X_1 commuting time	min	.005	.102
	X_2 commuting mode	Bus and other=1， Car=0	1.395	.163

	X_3 average monthly Income*bus and other	Cross variable	.838	.079
	X_4 commuting time*bus and other	Cross variable	.004	.331
	X_5 age	Year	-.278	.000
	X_6 square of the age	Year	.003	.000
	X_7 gender	Male=1 Female=2	.169	.439
	X_8 family population	Person	.100	.360
	X_9 whether the property	Yes=1 No=0	.310	.337
	X_{11} distance to nearest bus station	Meter	.481	.006
	X_{10} average household income=1]	Below 2000=1 2000-5000=2	2.592	.003
	[X_{10} average household income=2]	5001-10000=3 10001-20000=4	1.045	.036
	[X_{10} average household income=3]	More than 20000=5	0b	.
Y=1	Constant		-5.480	.000
	X_1 commuting time	min	.005	.015
	X_2 commuting mode	Bus and other=1, Car=0	-.462	.462
	X_3 average Monthly Income*bus and other	Cross variable	.195	.501
	X_4 commuting time*bus and other	Cross variable	.002	.484
	X_5 age	Year	.039	.270
	X_6 square of the age	Year	-.001	.238
	X_7 gender	Male=1 Female=2	-.065	.491
	X_8 family population	Person	.098	.059
	X_9 whether the property	Yes=1	.571	.000

		No=0		
	X_{11} distance to nearest bus station	Meter	.074	.341
	X_{10} average household income=1]	Below 2000=1 2000-5000=2	1.748	.001
	[X_{10} average household income=2]	5001-10000=3 10001-20000=4	1.073	.000
	[X_{10} average household income=3]	More than 20000=5	0b	.
Y=2	Constant		-2.398	.000
	X_1 commuting time	min	-.001	.053
	X_2 commuting mode	Bus and other=1， Car=0	.100	.554
	X_3 average Monthly Income*bus and other	Cross variable	.196	.006
	X_4 commuting time*bus and other	Cross variable	.007	.000
	X_5 age	Year	.028	.011
	X_6 square of the age	Year	.000	.018
	X_7 gender	Male=1 Female=2	-.033	.269
	X_8 family population	Person	.111	.000
	X_9 whether the property	Yes=1 No=0	.405	.000
	X_{11} distance to nearest bus station	Meter	.175	.000
	X_{10} average household income=1]	Below 2000=1 2000-5000=2	1.130	.000
	[X_{10} average household income=2]	5001-10000=3 10001-20000=4	.906	.000
	[X_{10} average household income=3]	More than 20000=5	0b	.
Y=3	Constant		-.598	.031
	X_1 commuting time	min	-.001	.501
	X_2 commuting mode	Bus and other=1，	-.054	.722

	Car=0		
X_3 average Monthly Income*bus and other	Cross variable	.010	.874
X_4 commuting time*bus and other	Cross variable	.005	.000
X_5 age	Year	.012	.256
X_6 square of the age	Year	.000	.065
X_7 gender	Male=1 Female=2	-.023	.414
X_8 family population	Person	.025	.123
X_9 whether the property	Yes=1 No=0	.128	.009
X_{11} distance to nearest bus station	Meter	.235	.000
X_{10} average household income=1]	Below 2000=1 2000-5000=2	-.142	.213
[X_{10} average household income=2]	5001-10000=3 10001-20000=4	.307	.000
[X_{10} average household income=3]	More than 20000=5	0b	.

4.4 Employment Success Gap between the Low-income and High-income Groups

In order to highlight the impact of transportation on the disadvantaged groups in the city, this part focuses on the impact of transport infrastructure on the employment status and employment satisfaction of low-income groups by income, and public transit user by travel mode.

Firstly, it focuses on the impact of transportation infrastructure on the employment status and employment satisfaction of low-income groups. Based on the overall samples, 14415 samples were selected from the overall sample to analyze the low-income groups in Urumqi, accounting for about 40.04% of the total sample. 21580 samples were selected to analyze for the high-income groups among residents surveyed in Urumqi, accounting for 59.96% of the total sample.

(1) Employment status between low-income groups and high-income groups

From the results of the regression analysis on employment status, it finds that commuting time and commuting mode are not significant. But if also finds that commuting time*bus and other (X_4) is significant, it shows that longer commuting time on public transit might induce unemployment for the lower income groups. Also, the nearest distance to BRT stops, the better employment status. And the coefficient is higher than the overall samples. There was a significant trend in the respondents' personal attributes and distance variable attributes and the positive and negative trends in correlation were the same as those of the overall sample.

Table 7. The regression model of the employment status of low-income groups in Urumqi

Variable	Unit	Employment status	
		β	Sig
R^2	0.075		
Durbin-Watson	1.417		
Constant		.571	.000
Explanatory variable			
X_1 commuting time	min	.000	.117
X_2 commuting mode	bus and other=1，Car=0	-.024	.141
X_3 Average monthly family income*bus and other	Cross variable	.012	.076
X_4 commuting time*bus and other	Cross variable	.000	.025
X_5 age	Year	.026	.000
X_6 age*age	Year	.000	.000
X_7 gender	Male=1 Female=2	-.009	.003
X_8 family population	Person	-.011	.000
X_9 ownership of poverty	Yes=1 No=0	.014	.007
X_{11} distance to the nearest bus station	Meter	-.005	0.033

Dependent variable		
Employment status	Full-time=1，Others=0	

The regression analysis of the employment status of the high-income groups indicates that high-income group which chose to drive a car to work in Urumqi had a higher rate of full-time working status. Commuting time has no significant relevance for the working status, but commuting mode for public transit has negative impact on the employment status.

Table 8. The regression model of the working status of high-income groups in Urumqi

Variable	Unit	Employment status	
		β	Sig
R^2	.063		
Durbin-Watson	1.417		
Constant		.645	.000
Explanatory variable			
X_1 Commuting time	min	-5.363E-005	.580
X_2 Commuting mode	bus and other=1，Car=0	-.046	.000
X_3 Average monthly family income*bus and other	Cross variable	.013	.000
X_4 Commuting time*bus and other	Cross variable	.000	.143
X_5 Age	Year	.023	.000
X_6 Age*Age	Year	.000	.000
X_7 Gender	Male=1 Female=2	-.017	.000
X_8 Family population	Person	-.009	.000
X_9 Ownership of poverty	Yes=1 No=0	.024	.000

X_{11} Distance to the nearest bus station	Meter	.001	.739
Dependent variable			
Employment status	Full-time=1，Others=0		

(3) Job satisfaction between low-income groups and high-income groups

From the results of the regression analysis of low-income groups, commuting time and Commuting time*bus and other show significant negative impact on job satisfaction. Among the personal attributes, the impact of age, gender on job satisfaction are not significant. Property ownership had positive, while family population had negative impact on job satisfaction. The distance to the nearest BRT stop has a negative impact, which indicates that the convenience access to BRT stop improve job satisfaction.

Table 9. Job Satisfaction regression model for Urumqi Low-income groups

Variable	Unit	Job Satisfaction Model	
		β	Sig
R^2	.041		
Durbin-Watson	.882		
Constant		2.860	.000
Explanatory variable			
X_1 Commuting time	min	-.001	.011
X_2 Commuting mode	bus and other=1，Car=0	-.112	.126
X_3Average monthly family income*bus and other	Cross variable	-.027	.373
X_4 Commuting time*bus and other	Cross variable	-.001	.012
X_5 Age	Year	-.003	.486
X_6 Age*age	Year	4.798E-005	.432
X_7 Gender	Male=1	-.014	.276

	Female=2		
X_8 Family population	Person	-.036	.000
X_9 Ownership of poverty	Yes=1 No=0	.106	.000
X_{11} Distance to the nearest bus station	Meter	-.026	.013
Dependent variable			
Employment satisfaction	Very satisfied=4， Satisfied=3， Commonly=2 ， Dissatisfied=1， Very dissatisfied=0		

The job satisfaction of the Urumqi high-income groups is analyzed by regression analysis. The commute time of the high-income earners became significant, indicating that the longer the commute time, the higher the satisfaction while it was not the same as the traditional theoretical results. X_3 of the crossover variables became significant, meaning that high-income groups who chose to drive the car to work in Urumqi had a higher degree of job satisfaction. In the case of personal factors, age has negative while property ownership has positive impact on job satisfaction for the high-income groups.

Table 10. Job satisfaction regression model for Urumqi high-income groups

Variable	Unit	Job Satisfaction Model	
		β	Sig
R^2	.019		
Durbin-Watson	.857		
Constant		3.244	.000
Explanatory variable			
X_1 Commuting time	min	.000	.000
X_2 Commuting mode	bus and other=1， Car=0	-.415	.228
X_3 Average monthly family income*bus and	Cross variable	.141	.000

other			
X_4 Commuting time*bus and other	Cross variable	-.001	.000
X_5 Age	Year	-.005	.031
X_6 Age*Age	Year	4.068E-005	.241
X_7 Gender	Male=1 Female=2	.001	.427
X_8 Family population	Person	-.028	.930
X_9 Ownership of poverty	Yes=1 No=0	.133	.000
X_{11} Distance to the nearest bus station	Meter	-.059	.000
Dependent variable			
Employment satisfaction	Very satisfied=4， Satisfied=3， Commonly=2 ， Dissatisfied=1， Very dissatisfied=0		

5 Summary

This paper is a case study of Urumqi, the capital of Xinjiang autonomous region in Western China., it investigates the impact of transportation infrastructure on the employment of low-income workers. In recent years, as a city located as "The Belt and Road" bridgehead, Urumqi is rapidly advancing the construction of public transport infrastructure. The study of the role of public transport infrastructure for employment accessibility will have special significance for evaluating the social impact and Urumqi's influence on regional economic development and infrastructure construction in the future.

In terms of the job-housing spatial relationship on city scale, using employment and population density based on TAZ as a basic unit from 2010 to 2014, the job-housing balance ratio of the area that the BRT lines go through is increased. However, due to the lack of BRT lines in minority groups concentrated areas, the improvement of job opportunities in the minority groups concentrated area is not obvious. Meanwhile, by ranking the bus densities in each TAZ, it finds that public transit infrastructure is still insufficient in some remote location in the suburban areas.

Based on transport survey data, this paper investigates the impact of factors such as commute time, distance, mode of transportation and distance to the nearest BRT site on employment status and employment satisfaction through establishing regression model. Results shows that in terms of transportation related factors, distance to the nearest bus BRT stop has negative impact on employment status and job satisfaction almost in all the regression. Commuting time is not significant for the overall samples, but has negative impact on the low-income groups' job satisfaction. In terms of individual attributes, younger age, the males, higher income groups and property owner have better level of employment status and job satisfaction in most of the regressions.

In summary, transportation infrastructure construction in Urumqi is not only a technical achievement, but can have a more profound impact in terms of social justice and economic development in the city. The study found that the impact of transport infrastructure investment may not only help improve the employment accessibility of the low-income groups. Under the context of China's "the Belt and Road" initiative, it is of particular significance to study the transportation infrastructure construction of western ethnic minority cities to promote regional economic development.

References

Abramson, A. J., Tobin, M. S., & VanderGoot, M. R. (1995). The changing geography of metropolitan opportunity: The segregation of the poor in U.S. metropolitan areas, 1970 to 1990. Housing Policy Debate, 6(1), 45–72.

Baum, . (2010). En-gendering effective planning: Spatial mismatch, low-income

Blumenberg E, Pierce G. Multimodal travel and the poor: evidence from the 2009 National Household Travel Survey[J]. Transportation Letters the International Journal of Transportation Research, 2014, 6(1):36-45.

Blumenberg, E., & Pierce, G. (2012). Automobile ownership and travel by the poor. Transportation Research Record: Journal of the Transportation Research Board, 2320(1), 28–36. doi:10.3141/2320-04

Chen, Jin, S.M. Massachusetts Institute of Technology. Determinants of the spatial dynamics of housing prices in Chengdu, China, 2005-2010[J]. Massachusetts Institute of Technology, 2013.

Dalenberg D R, Partridge M D, Rickman D S. Public infrastructure: pork or jobs creator?[J]. Public Finance Review, 1998, 26(1): 24-52.

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

Giuliano, G., & Small, K. A. (1991). Subcenters in the Los Angeles region. Regional Science and Urban Economics, 21(2), 163–182. doi:10.1016/0166-0462(91)90032-I

Handy S L, Niemeier D A. Measuring accessibility: an exploration of issues and alternatives[J]. Environment & Planning A, 1997, 29(7):1175-1194.

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.

Holl A. 2004. Manufacturing location and impacts of road transport infrastructure: Empirical evidence from Spain. Regional Science and Urban Economics, 34(3): 341-363.

Holzer, H. J. (1991). The spatial mismatch hypothesis: What has the evidence shown? Urban Studies, 28(1), 105–122. doi:10.1080/00420989120080071

Hu, L. (2015). Changing job access of the poor: Effects of spatial and socioeconomic

Jargowsky, P. A. (2003). Stunning progress, hidden problems. Washington, DC: The Brookings Institution.

Kain, JohnKain J F. Housing segregation, negro employment, and metropolitan decentralization. Quarterly Journal of Eco- nomics, 1968, 82: 175-197

Kawabata, M. (2003). Job access and employment among low-skilled autoless workers inUS metropolitan areas. Environment and Planning A, 35(9), 1651–1668. doi:10.1068/a35209

Laird J, Batley R, Nash C, et al. Option values, non-use values and transport appraisal - final report[J]. Mathematical Models, 2006.

Laird J, Nellthorp J, Mackie P. 2005. Network effects and total economic impact in transport appraisal. Transport Policy, 12(6): 537-544.

Lindsey D, Schiesl M. Whittier Narrows Flood Control Basin Historic Resources Survey,[J]. Whittier Narrows Flood Control Basin Historic Resources Survey, 1976.

Ong, P. M., & Miller, D. (2005). Spatial and transportation mismatch in Los Angeles. Journal of Planning Education and Research, 25(1), 43–56. doi:10.1177/0739456X04270244

Shen, Q. (2001). A spatial analysis of job openings and access in a US metropolitan area. Journal of the American Planning Association, 67(1), 53–68. doi:10.1080/01944360108976355

Stoll, M. A., & Covington, K. (2012). Explaining racial/ethnic gaps in spatial mismatch

Taylor, B. D., & Ong, P. M. (1995). Spatial mismatch or automobile mismatch? An examination of race, residence and commuting in US metropolitan areas. Urban Studies, 32(9), 1453–1473. doi:10.1080/00420989550012348

transformations in Chicago, 1990–2010. Urban Studies, 51(4), 675–692. doi:10.1177/0042098013492229

Wachs M, Kumagai T G. Physical accessibility as a social indicator[J]. Socio-Economic Planning Sciences, 1973, 7(5):437-456.

Wachs M. Transportation policy in the eighties[J]. Transportation, 1977, 6(2):103-118.

Watson R. Commentary on Nairn S, O'Brien E, Traynor V, Williams G, Chapple M & Johnson S (2006) Student nurses' knowledge, skills and attitudes towards the use of portfolios in a school of nursing. Journal of Clinical Nursing15, 1509-1520.[J]. Journal of Clinical Nursing, 2007, 16(3):616-7.

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: 1-11.