Job accessibility effects on employment for urban immigrants of Taiwanese Aborigines

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Abstract

This study empirically analyzes the effects of job accessibility on the employment of Taiwan's aboriginal peoples residing in urban areas. The study population is aborigines who migrated to Taipei County from their native locales in 2008. Sample data were collected via a questionnaire survey. Various econometric methods, including the binary logit model, ordered logit model and linear regression model, were employed to analyze job accessibility effects on being employed, employment stability, salary and commuting time, respectively. Study results indicate that car accessibility positively affected monthly salary; motorcycle accessibility and transit headway positively affected commuting time; and raising aggregate accessibility reduced commuting time. However, the relationships between job accessibility and employment stability were insignificant for sample data. The empirical evidence contribute to the knowledge of relationships between access to job and employment for ethnic minorities.

Keywords: job accessibility, ethnic minority, employment

1 Introduction

Aborigine commonly refers to to the indigenous peoples of Taiwan. Although Taiwanese indigenous groups believe in a variety of creation stories, recent research suggests that their ancestors may have lived on the island for approximately 8,000 years before Chinese immigration began in the 17th Century (Blust, 1999). Taiwanese aboriginal settlements were once distributed over much of the island's rugged central mountain range and concentrated along Taiwan's alluvial plains. As of December 2008, the total aboriginal population was around 494,107 (approximately 2.1% of Taiwan's total population).

Aboriginal peoples in Taiwan have had many long-term disadvantages associated with employment and economic status. To find relatively better job opportunities and employment conditions, an increasing number of aborigines have migrated from their villages to cities. An investigation by the Council of Indigenous Peoples, Executive Yuan (2006), found that the average unemployment rate of aboriginal peoples in 2006 for Taiwan, Taipei City and Taipei County were 4.36%, 3.67% and 4.13% respectively. Taipei is the most major metropolitan area in Taiwan and performs significant low unemployment rate as compared with the other areas. Another investigation by the Council of Indigenous Peoples, Executive Yuan (2007), reported that the growth rate of aboriginal household income during 2002–2006 was 12.1%, while that for Taipei was 34.8%. Although aborigines in urban areas have better employment conditions than those in traditional villages, the economic conditions of urban aborigines remain significantly

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worse than that of the general population. The 2006 Manpower Utilization Survey (Directorate-General of Budget, Accounting and Statistics, Executive Yuan, 2006) indicated that the average monthly salary of a Taiwanese worker was NT$35,664, while that of an aborigine in Taipei was merely NT$19,663. Because of poor economic conditions and housing affordability, aborigines typically reside in areas with low land prices and poor accessibility when immigrating to cities. Residing in a location with poor accessibility limits job opportunities and can result in problems associated with social exclusion.

Job accessibility is the convenience with which one can overcome barriers between residence and employment. Improving job accessibility increases employment opportunities. Numerous studies have focused on job accessibility in US (Gao *et al*., 2007; Kawabata, 2003a; Kawabata and Shen, 2004; 2006; Sanchez, 1999; Sanchez *et al*., 2003; Parks, 2004), Sweden (Åslund *et al*., 2006), Japan (Kawabata and Shen, 2004; 2006) and Hong Kong (Lau and Chiu, 2003). These studies explored the effects of job accessibility on unemployment, salary, commuting distance, and time using traffic analysis zones or households as a sample. An increasing number of studies have examined the influences of job accessibility on employment of economic minorities such as welfare recipients (Bania *et al.*, 2008; Kawabata, 2003b; Ong and Blumenberg, 1998), low-income households (Sanchez *et al*., 2003) and native-born blacks and immigrant women (Parks, 2004). Studies of minority access to jobs, facilities and services provide references connecting spatial planning and social welfare policies. For example, accessibility planning approaches in the UK (Social Exclusion Unit, 2003) and New Zealand (Chapman and Doug, 2008) were developed to improve access to work, learning, healthcare and affordable foods via integrated spatial plans involving land uses, facilities and transportation systems.

Aboriginal employment had been widely explored in Taiwan. Lin (2005) argued that the two reasons causing aborigines to migrate to cities are push factors in native locales, including inconvenient transportation, poor economy and insufficient job opportunities, and pull factors in urban areas, including more job opportunities, higher salary and better living conditions. Recent studies, including those by Chiang (2004), Ho (2002), Kuo (2007), Lin (2002), Lin (2003), Sheu (2003), Tzeng (2004) and Wu (2000), examined the influences of individual, household, job and social attributes on job transfer, job-related migration, unemployment, income, occupation and employment stability. Although few studies, such as that by Lin (2003), discussed job opportunities and transportation systems in aboriginal areas, job accessibility issues faced by Taiwanese aborigines in urban areas remain unexplored; that is, further investigation is needed to provide references for improving aboriginal employment conditions in urban areas.

This study empirically analyzed the effects of job accessibility on the employment of Taiwanese aborigines in urban areas. The study population is aborigines who moved to Taipei County in 2008 from their native villages. Various econometric methods, including the binary logit model, ordered logit model and linear regression model, were employed to analyze job accessibility effects on being employed, employment stability, salary and commuting time, respectively. Based on empirical results, local governments can develop land use and transportation strategies that improve aboriginal employment conditions in urban areas. The remainder of this paper is organized as follows. Section 2 introduces the

research design. Section 3 describes data collection methods. Section 4 presents the model calibration results. Conclusions are given in Section 5, along with recommendations for future research.

2 Research Design

This section first specifies the study employment items and possible factors affecting study items. Subsequently, the hypotheses, the model specifications and the analytical methods are described.

2.1 Studied employment items

Various employment items have been investigated in previous job accessibility studies. Sanchez *et al.* (2003) determined whether welfare recipients were employed. Kawabata (2003a) and Sanchez (1999) discussed weekly working hours, which are related to employment stability. Ong and Blumenberg (1998), Kawabata (2003b) and Åslund *et al.* (2006) examined worker salaries. Lau and Chiu (2003) and Ong and Blumenberg (1998) examined commuting distances and durations. This study analyzed the following four items simultaneously.

The first item is whether a worker is employed. Having a job is a basic requirement from an economic perspective. This study used the definition of employment from the International Labor Organization to determine whether a worker is employed. The second item is employment stability. According to the investigation by the Council of Indigenous Peoples, Executive Yuan (2007), most aboriginal employees were working in labor-based jobs, including construction (18.3%), agriculture, forestry, fishery and animal husbandry (AFFH) (15.7%) and manufacturing (15.7%). In Taiwan, construction jobs are usually short-term contracts and AFFH jobs are constantly seasonal. Unstable employment has deleterious effects on the lives of aborigines. This study classified employment stability into being unemployed, being unemployed but sometimes having paid work, usually employed but sometimes having no paid work, and being stably employed. The third item is salary. The investigation by the Council of Indigenous Peoples, Executive Yuan (2007), found that aborigines in urban areas carry more debt than other aborigines in Taiwan. Increased job-related income raises one's ability to decrease debt and supporting one's life. Employee monthly salary is commonly used as job-related income. The last item is commuting time. Excessive commuting time can decrease work performance and consume disposable income. Very few job accessibility studies, such as that by Ong and Blumenberg (1998), examined commuting time. This study used one-way travel time for an employee from home to work as the measure of commuting time.

Three variable categories have been used in previously job accessibility studies— transportation, location and the individual. Transportation accessibility measures the convenience of accessing jobs via a specific travel mode such as car and public transit (Kawabata, 2003a, b; Kawabata and Shen 2004, 2006). Location accessibility measures the spatial distances between a residence and transit stations or work places (Sanchez, 1999; Sanchez *et al*. 2003; Åslund *et al*. 2006). Individual accessibility represents personal attributes, preferences or habits associated with accessibility. For example, Lau and Chiu (2003) argued that married female workers usually have more responsibility for family care and typically work closer to homes than males. Sanchez *et al.* (2003) concluded that age, gender and race of a welfare recipient are related to job accessibility.

Since individual accessibility variables are commonly not associated with built environments, this study used these variables as control variables rather accessibility variables during model calibration and analyses.

This study examined four accessibility variables (Table 1). The first variable is transportation accessibility, and the last three are focused on location accessibility. Following the accessibility functions in the study by Sanchez *et al.* (2003), four sub-variables were used to measure transportation accessibility by car, public transit, motorcycle and mode-aggregate as follows:

$$A_i^{\ c} = \sum_j \frac{E_j \times f(C_{ij}^{\ c})}{\sum_k [\alpha_k W_k \times f(C_{kj}^{\ c}) + \beta_k W_k \times f(C_{kj}^{\ t}) + \gamma_k W_k \times f(C_{kj}^{\ m})]} \tag{1}$$

$$A_i^{\ t} = \sum_j \frac{E_j \times f(C_{ij}^{\ t})}{\sum_k [\alpha_k W_k \times f(C_{kj}^{\ c}) + \beta_k W_k \times f(C_{kj}^{\ t}) + \gamma_k W_k \times f(C_{kj}^{\ m})]} \tag{2}$$

$$A_i^{\ m} = \sum_j \frac{E_j \times f(C_{ij}^{\ m})}{\sum_k [\alpha_k W_k \times f(C_{kj}^{\ c}) + \beta_k W_k \times f(C_{kj}^{\ t}) + \gamma_k W_k \times f(C_{kj}^{\ m})]} \tag{3}$$

$$A_i = \alpha_i A_i^{\ c} + \beta_i A_i^{\ t} + \gamma_i A_i^{\ m} \tag{4}$$

where $A_i^{\ c}$, $A_i^{\ t}$, $A_i^{\ m}$ and A_i are car, public transit, motorcycle and aggregate accessibilities in zone i, respectively; E_j and w_k are the numbers of employees and workers, respectively, in zone j or k; α_k, β_k and γ_k are modal splits for cars, public transit and motorcycles, respectively, in zone k; $c_{ij}^{\ c}$, $c_{ij}^{\ t}$ and $c_{ij}^{\ m}$ are generalized travel costs from i to j by car, public transit and motorcycle, respectively; and *f*(.) is an impedance function. This study defined the zones in Eqs. (1)–(4) as 388 *traffic analysis zones* (TAZs) in metropolitan Taipei.

In addition to job accessibility, personal, household and social conditions are also important in explaining employment, and were used as control variables in this study. To analyze the employment of Taiwanese aborigines in urban areas, this study classified control variables into four layers—individual, household, job and society. The individual layer encompasses age, gender, marriage, education and vehicle ownership of an aboriginal worker (Table 1). The household layer is concerned with the number of dependents and migration frequency of an aborigine. The job layer is focused on an employee's position, work hours, work experience, occupation, commuting patterns, job allowance and commuter services provided by employers. Finally, the social layer is concerned with the unemployment rate in the area where a sample aborigine resides.

Table 1 Explanatory variables and hypothetical relationships

Variables / Employment	Being employed	Employment stability	Salary	Commuting time
Accessibility variables				
Transportation accessibility	+	+	+	−
Transit headway				+
Walking distance to transit station	−	−		+
Jobs within 5 km	+	+	+	
Control variables				

Variable				
Age		+	+	−
Gender (male)	△	△	△	+
Marriage		△		+
Education	+	+	+	
Vehicle ownership	+		+	−
License ownership	+		+	
Dependents	−		△	−
Migration frequency	−	−		
Position			+	
Work hours			+	
Work experience		+		
Occupation	△	△	△	
Commuting distance				+
Number of transfers		−		+
Job allowance		+	+	
Commuter bus service				−
Unemployment rate	−	−		+

P.s. + denotes positive effect, - denotes negative effect, △ denotes the possible existence of both + and -.

2.2 Hypotheses

Table 1 lists the hypothetical relationships between study variables and employment. These hypotheses were based on literature, logical reasoning and field interviews. Field interviews were conducted during September and October of 2008. The following were the four interviewees: interviewee [0908] is a male aborigine who moved to Taipei 16 years ago and is stably employed by a freight transportation company; interviewee [0909] is a female aborigine who moved to Taipei less than one year ago and is employed by a financial company; interviewee [0922] is a male aborigine who moved to Taipei six years ago and has various part time jobs; and, interviewee [1019] is a male aborigine who moved to Taipei seven years ago and has been unemployed for six months. The following subsections describe the bases for the hypothetical relationships (Table 1).

2.2.1 Being employed

Sanchez *et al.* (2003) showed that decreased walking distances to transit stations improved a welfare recipient's employment. Thus, a negative effect of walking distance to a transit station on employment may exist. Sanchez *et al*. (2003) also found a negative relationship between age and employment status and inconsistent relationships between gender and employment status in different cities. Sheu (2003) reported that insufficient education and the economic recession resulted in unemployment for many Taiwanese aborigines.

Logically, increasing job opportunities easily accessed from a worker's residence raise the opportunity of being employed for workers. Thus, the number of jobs within a five-kilometer radius and transportation accessibility from a worker's residence is positively related to a worker's opportunity to being employed. Owning professional licenses and vehicles enhances a worker's technical proficiency and work abilities, thus increasing the opportunity to be employed. Increasing the number of household dependents increases responsibility for dependents and, thus, a worker may have

difficulty obtained a job that does not conflict with caring for dependents. An aborigine who migrates frequently to urban areas has difficulty developing stable social networks and, hence, would have difficulty finding work. Different occupations have different degrees of competitiveness for jobs and, thus, the effects of occupation on employment of a worker cannot be clearly identified before empirical analysis.

Field interviews confirmed the positive effects of job accessibility on being employed for a worker. One interviewee stated,

I had no adequate job for a half year when I resided in Wugu, which is very far from transit stations. Last week, I moved to Tamsui, which is served by the metro system, and was immediately employed a couple of days ago. [1019]

Another interviewee stated,

I prefer jobs near my house. Of course, you can say that increasing the number of jobs nearby one's home increases the possibility of having an adequate job. [0922]

Interviews also indicated that owning a vehicle enhances the opportunity of being employed.

If you own and use a private vehicle, it is convenient to arrange many interviews in one day. Using the transit system is less flexible than using private vehicles. [0909]

Owning and using a private vehicle improves travel time estimations and work arrangements, both of which contribute to productivity and the opportunity of being employed. [0922]

2.2.2 Employment stability

Sanchez (1999) identified a negative relationship between distances to transit stations and weekly work hours. Thus, walking to transit stations can decrease employment stability. Some Taiwanese aboriginal studies have examined the control variable effects on aboriginal employment stability. Sheu (2003) found that insufficient education, the economic recession and frequent moving decrease work hours. Wu (2000) identified a negative relationship between moving frequency and employment stability for aborigines. Kuo (2007) concluded that occupation and education are associated with employment stability.

Logically, increasing the number of nearby jobs increases the likelihood of having a stable job. Thus, job accessibility may be positively associated employment stability. Age and experience contribute to employment stability because employers commonly prefer mature workers. An advanced education and license ownership enhance work capability, which benefits employment stability. Frequent moving can result in frequent job changes, thereby decreasing employment stability. Increasing the number of transfers on public transit increases commuting obstacles and willingness to transfer jobs. Good pay attracts employees, who often stay at that job, while a high unemployment rate makes jobs difficult to find.

The field interviews described the effects of marriage on employment stability.

If you are married, you have family responsibilities and need a stable income and job. Briefly, a married guy tends to keep his job. [0922]

Married workers usually have to move their attention from work to their mates and children. Such distractions can cause poor work performance and unstable employment. [0909]

An interviewee's experience shows that a reduced number of transfers during commuting increases employment stability.

I quit one of my jobs after working for only one month, because I didn't own a car or a motorcycle and had to transfer twice on transit when commuting between home and the office. Transit transfers are troublesome, cost time and make me tired. [0922]

2.2.3 Salary

Åslund *et al.* (2006) identified a positive effect of job accessibility (measured by the number of jobs within 5 kilometers of a workers home) on salary. Kawabata (2003b) empirically verified a positive effect of education of a welfare recipient on his/her salary. A study of Taiwanese aborigines by Kuo (2007) discovered positive relationships between age, education and license ownership and salary. Kuo (2007) also found significant differences in salary among various occupations.

Logically, a team leader has more job responsibility and a higher salary than a team member. Hence, position positively affects salary. Males are traditionally expected to work more and, thus, are paid more than females. A worker's salary commonly grows with hours worked and, thus, hours worked has a positive effect on salary. A work may give up a well-paid distant job and choose a nearby job based on the need to care for dependents. Conversely, a worker with a car or motorcycle can reach distant jobs and, thus, has more opportunity to obtain well-paid jobs than a worker without a vehicle. Furthermore, since job allowances of a company raises employee salaries, we expect a positive relationship exists between allowance and salary.

The field interviews confirmed that differences of salary were based on employee gender.

In the factory where I work, most female workers are field operators, who handle non-technical tasks and receive less payment (about NT$18,000–20,000/month) than other workers. [1019]

Male workers earn higher salaries than female workers in the manufacturing and service industries. [0909]

The interviewee [0909] identified gender-based prejudice. On the other hand, the following responses express the potential effects of family dependents on salary.

Are you asking if dependents impact salary? It depends on an individual's personality. If one values dependents, they will choose a nearby job that may have less pay than distant jobs; otherwise, if one places importance on material life, they will choose the well-paid job, which may be a distant job, to support dependents. [0909]

2.2.4 Commuting time

Lao and Chiu (2003) concluded that commuting transfers lengthen commuting time, and female workers have shorter commuting time than male workers. Because Asian females typically have the greatest responsibilities for children and housework, they tend

to choose nearby jobs to decrease travel time. Ong and Blumenberg (1998) also determined that males had longer commuting times than females. They also identified a negative effect of worker age on commuting time. Young workers are willing to commute farther to take a good job.

Logically, increased walking distances to transit stations and headways of transit services increase wait time when using transit, thereby increasing commuting time. Owning a personal vehicle (car or motorcycle) and commuter bus service from an employer raise worker mobility and can shorten commuting time. Furthermore, an increased unemployment rate for workers residing in an area decreases the likelihood of finding a good job nearby, and thus lengthens commuting time.

The following field records support the negative effect of female, marriage and dependents on commuting time.

One of my clients, a married female, gave up a well-paid distant job. She is now working near her community and looking after her children. Married females are always concerned about their dependents and prefer jobs near their homes, even when the pay is low. [0908]

This study proposes the following four hypotheses.

H1: Job accessibility positively affects the likelihood that an aborigine will be employed.

H2: Job accessibility positively affects the employment stability of an aborigine.

H3: Job accessibility positively affects an aborigine's salary.

H4: Job accessibility negatively affects an aborigine's commuting time.

2.3 Analytical methods

To verify these hypotheses, this study used individual labor force[3] as a sample observation. Based on dependent variable attributes, three regression methods were applied to analyze sample data. First, whether a worker is employed or not is a binary distinction; thus, this study employed the binary logit model to test H1 and coded *employed* as 1. Second, because the conditions of employment stability are ordinal, this study used the ordered logit model to test H2 and coded conditions as follows: unemployed (=0); unemployed but sometimes having paid work (=1); usually employed but sometimes having no paid work (=2); and, stably employed (=3). The first two models were calibrated using the maximum likelihood method and Limdep 8.0. Finally, the linear regression model was applied to test H3 and H4 because salary and commuting time are both continuous values. This study employed the least squares method and SPSS 12.0 to calibrate linear regression models.

Table 2 lists the definitions of independent variables used in regression models. The four hypotheses were empirically tested according to the signs and significances of calibrated coefficients of accessibility variables in the corresponding regression models.

Table 2 Definitions of explanatory variables

Variables	Definitions	Units
Accessibility variables		

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[3] A labor force is those employed or actively seeking employment aged 15–65 years.

Transportation accessibility	As in Eqs. (1)–(4).	--
Transit headway	Average headway of transit services from the nearest station from home.	minute
Walking distance to transit station	Walking distance to the nearest transit station from home.	meter
Jobs within 5 km	Number of jobs within 5 kilometers of home.	--
Control variables		
Age	Age of respondent.	year
Gender (male)	A respondent is male (=1) or female (=0).	--
Marriage	A respondent is married (=1) or unmarried (=0).	--
Education	The highest level of a respondent's education: $X_{edu3}=1$, bachelor degree or higher; $X_{edu2}=1$, senior high school; $X_{edu1}=1$, junior high school; and $X_{edu1}=X_{edu2}=X_{edu3}=0$, elementary school or uneducated.	--
Vehicle ownership	Vehicle ownership: $X_{veh3}=1$, both car and motorcycle; $X_{veh2}=1$, only car; $X_{veh1}=1$, only motorcycle; and $X_{veh1}=X_{veh2}=X_{veh3}=0$, none.	--
License ownership	Number of licenses owned by a respondent.	--
Dependents	Number of dependents supported by a respondent.	people
Migration frequency	Number of times one moved after moving to urban areas from a respondent's homeland.	--
Position	A respondent is (=1) or is not (=0) a superintendent.	--
Work hours	Weekly work hours.	hour
Work experience	Total work years of a respondent.	year
Occupation	A respondent's occupation: $X_{occ2}=1$, tertiary industry; $X_{occ1}=1$, secondary industry; and $X_{occ1}=X_{occ2}=0$, other.	--
Commuting distance	A respondent's commuting distance.	km
Number of transfers	The number of transfers when using public transit systems for a work trip: $X_{tra2}=1$, 2 or more; $X_{tra1}=1$, 1; and $X_{tra2}=X_{tra1}=0$, not required.	--
Job allowance	Allowance provided by an employer in addition to normal salary.	NT$
Commuter bus service	A respondent's employer provides (=1) or does not provide (=0) commuter bus service.	--
Unemployment rate	Unemployment rate of the administrative district where a respondent resides.	%

3 Data

Urban aborigines in Taiwan moved from aboriginal areas, which, according to the Council of Indigenous Peoples in Taiwan, include 30 mountain villages and 25 plain villages, to urban areas for permanent residence or work. Taipei County contains the highest percentage of urban aborigines in Taiwan (Council of Indigenous Peoples, Executive Yuan, 2006). This study used the county[4] as its sample area. The county contains 10 cities, 4 townships and 15 villages in a land area of 2052.57 km². Roughly 46,125 aborigines, about 9% of Taiwan's total aboriginal population, resided in the county in January 2009. Because new immigrants in a city commonly have weak social

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[4] The Wulai Village in Taipei County is an Aboriginal Area and was excluded from the sampling area.

networks and face significant employment barriers, this study chose the aboriginal labor force (aged 15–65 years) that moved to Taipei County in 2008 as the study sample. The sample frame was from the Civil Affairs Bureau, Taipei County, and contained 3,363 people.

Variable data was obtained from two sources—a questionnaire survey and published documents. Questionnaires were delivered to all aborigines by mail. Each respondent who mailed back a completed questionnaire received NT$100 (about US$3). The survey period was February 2009. Collected data were employment attributes (employment situations, work experience, occupation, weekly hours worked and commuting time), household attributes (number of dependents, moving history, transit service headway and walking distances to transit stations), and individual attributes (gender, age, marriage, education, salary, vehicle ownership and license ownership). Of the 3,363 aborigines surveyed, 514 replied, of which 408 questionnaires were valid. The response rate was 15.3%, and the effective response rate was 79.3%.

Based on areas of residence indicated by respondents, data for the three variables were obtained from existing databases and published documents. First, the impedance functions and modal splits of transportation accessibility variables defined in Eqs. (1)–(4) were from calibrated trip distribution models and surveyed modal split data from the Department of Transportation, Taipei City (2001). Second, the job distribution among TAZs was from the 2006 Commerce and Service Census (Directorate-General of Budget, Accounting and Statistics (DGBAS)). Finally, unemployment rates of TAZs were from the 2008 Manpower Surveys completed by the DGBAS. All secondary data sources were the latest versions for the 388 TAZs in Taipei.

Figure 1 illustrates the percentage distribution of employment for the study sample. Only roughly 50% of respondents were stably employed; about 25% were usually employed but sometimes had no paid work; and, the rest (25%) of respondents were unemployed or occasionally had paid work. The unemployment rate for the study sample (13%) was significantly higher than the general average in Taiwan in 2008 (4.14%). Furthermore, average monthly salary of the study population (NT$27,214) was significantly lower than that of general population in Taiwan in 2008 (NT$44,424). We presume that the sample population of aborigines had much worse employment situations than the general public. On the other hand, average commute time of sample population was 25 minutes, less than the general average for metropolitan Taipei (33 minutes) in 2001 (Department of Transportation, Taipei City, 2001). Consequently, the commuting range of Taiwanese aborigines is likely smaller than that of the general public. The respondents had a similar composition as that of sample population: the male-to-female ratios were both 39:61, age medians were the same, age means were less than 1 year different and age variance coefficients only differed by 0.05.

Prior to model calibration, this study analyzed descriptive statistics of explanatory variables, correlations with other explanatory variables, and correlations with employment variables. The above analyses provided information on correlations among variables as a reference for determining explanatory variables during model calibration.
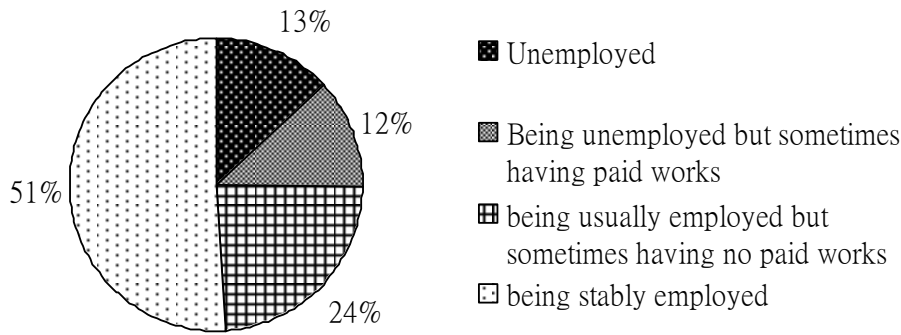
13% Unemployed

12% Being unemployed but sometimes having paid works

being usually employed but sometimes having no paid works

being stably employed

51%

24%

Figure 1 Employment distribution of the sample

4 Results

The four employment items were analyzed using three regression methods. For each item, the base model, which considered only control variables, and the expanded model, which considered control and accessibility variables, were both calibrated. Explanatory variables with a coefficient of significance below the confidence level of $1-\alpha=80\%$ were withdrawn. This study applied likelihood ratio tests and the F statistic of model differences to determine whether expanded models have superior goodness-of-fit to that of the base models, and whether job accessibility contributes significantly to explaining aboriginal employment.

Appendix lists the calibration results for eight models. The binary logit models for explaining whether an aborigine is employed had small ρ^2 values; however, their χ^2 tests both achieved significance at $\alpha=0.05$. Thus, this study accepted the calibrated models as methods for examining the effects of explanatory variables. Both the base and extended models demonstrated that male and education had positive effects on the possibility of being employed; this finding is consistent with expectations (Table 1). The extended model shows that all accessibility variables were insignificant in explaining whether an aborigine was employed. The likelihood ratio test also confirmed that the extended model did not significantly improve the goodness-of-fit of the base model. Thus, we conclude that empirical data do not support the significance of job accessibility on the possibility of being employed for an aborigine in urban areas. Conversely, the ordered logit models for explaining employment stability had ρ^2 values of 0.1952 and 0.2014, and both χ^2 tests achieved a significance level of $\alpha=0.05$. Thus, calibrated models can be used to examine the effects of explanatory variables. The base and expanded models determined that marriage, education, secondary/tertiary industry occupations and allowance had positive effects on employment stability. These effects are consistent with expectations (Table 1). The extended model shows that all accessibility variables were insignificant in explaining employment stability. The likelihood ratio test also proved that the extended model did not significantly improve the goodness-of-fit of the base model. We conclude that empirical data do not support the positive effect of job accessibility on employment stability for an aborigine in urban areas.

The linear regression models for explaining an aboriginal employee's salary were calibrated by using the generalized least squares method to deal with autocorrelations among the study population. The adjusted R^2 values indicate acceptable goodness-of-fit. The base and expanded models both show that marriage, education, car/motorcycle ownership, job position, work hours, secondary industry occupation and allowance positively and significantly impact salary. These effects are consistent with expectations (Table 1). Although the expanded model did not significantly improve the goodness-of-fit of the base model (based on the F statistic of model differences), car accessibility had a significant and positive effect on salary. The other two linear regression models for explaining commute time also had acceptable goodness-of-fit. The base and expanded models indicate that male, commute distance and number of transfers positively and significantly impacted commute time, which is consistent with expectations (Table 1). According to the F statistic of model difference, the expanded model significantly improved the goodness-of-fit of the base model. Decreasing transit headway and enhancing transit and aggregate accessibilities decreased commute time, while increasing motorcycle accessibility increased commute time. The latter is inconsistent with expectations and warrants further discussion.

Table 3 lists the accessibility variables that achieved a significance of $\alpha = 0.2$ in the Appendix models and their effects on aboriginal employment situations. The hypotheses were tested. First, all accessibility variables did not have significant effects on whether an aborigine is employed or on employment stability; therefore, hypotheses H1 and H2 are not supported by empirical data. Second, since car accessibility had a positive effect on salary, hypothesis H3 is supported by empirical data for car accessibility. We argue that residing in a highly car-accessible area increases the possibility of an aborigine obtaining a well-paid job. Finally, frequency and accessibility of transit services and aggregate accessibility decrease commute time; therefore, hypothesis H4 is supported by empirical data via transit and aggregate accessibilities. We believe it is reasonable that transit accessibility negatively affects commute time of an urban aborigine because disadvantaged minorities in urban areas rely heavily on public transit systems. However, the positive effect of motorcycle accessibility on commute time contradicts rational expectations (Table 1). This contradiction may occur because most respondents (about 57%) owned motorcycles and motorcycle commuters can commute long distances. The effect of motorcycle accessibility on commute time requires further study.

Table 3 Empirical effects of job accessibility on aboriginal employment

Accessibility Variables	Being employed	Employment stability	Salary	Commuting time
Car accessibility			+	
Motorcycle accessibility				+
Transit accessibility				-
Aggregate accessibility				-
Transit headway				+
Walking distance to transit station				
Jobs within 5 km				

P. S. +: positive effect, -: negative effect, □: a significance worse than α=0.2

The evidence in this study are both similar to and different from those for cities in previous studies. First, the positive effect of accessibility on opportunity for employment was insignificant for Taiwanese aborigines residing in Taipei, and significant for some

European and western US cities. A Swedish study by Åslund *et al.* (2006) concluded that an increased number of jobs within 5 km of a worker's house increased the opportunity of being employed. Parks (2004), who conducted a study in Los Angeles, demonstrated that increased job accessibility decreased unemployment rates for native-born blacks, foreign-born Mexicans and foreign-born Vietnamese. The insignificance of accessibility effect on being employed for an aboriginal worker in Taipei may be caused by the built environment and personal mobility. Dense and mixed land uses in Taipei shorten distances between residences and jobs and decrease spatial obstacles to employment. High values for vehicle ownership of respondents in this study (57% owned motorcycles and 23% owned cars) imply that urban aborigines have good mobility. The popular use of motorcycles in Taipei, as well as in other south-eastern Asian cities, provides disadvantaged minorities with mobility and benefits in reaching jobs.

Second, employment status had no relationship with job accessibility for disadvantaged minorities in previous studies and this study. Sanchez *et al.* (2004) indicated that access to fixed-route transit and concentrated employment was not associated with employment outcomes of welfare recipients in metropolitan areas in the US. The Taipei evidence generated similar analytical results for employment stability. Conversely, the significance of the relationship between accessibility and salary was weak in previous studies. Åslund *et al.* (2006) identified a significant and positive relationship between accessibility and salary in Sweden, while Kawabata (2003b) identified an insignificant relationship in Los Angeles. Both of these studies measured accessibility without considering transport modes. This study found an insignificant effect of aggregate accessibility on salary, and a significant and positive effect of car accessibility on salary. Thus, one must consider transportation modes when measuring job accessibility to explain salary.

Finally, this study verified the positive effect of number of transfers on commuting time, as was identified in a Hong Kong study by Lau and Chiu (2003). Additionally, transit service headway and accessibility variables had significant effects on worker commute time, which has been rarely explored in previous accessibility studies.

5 Conclusions

Most previous accessibility studies focused on economic or environmental impacts of transportation. An increasing number of studies in recent decades have explored social issues associated with accessibility, and which accessibility planning approaches can fix social exclusion for minority groups in the UK (Social Exclusion Unit, 2003) and New Zealand (Chapman and Doug, 2008). Studies of job accessibility effects on employment, especially for an economic minority with low-income households, new immigrants and ethnic minorities, is an essential transportation sociology issue. Although Taiwanese aborigines moving to urban areas are both new immigrants and ethnic minorities, previous aboriginal employment studies commonly examined the conflicts among individual attributes, tribal cultures and work attitudes of aboriginal workers in urban areas and ignored the relationships between residence accessibility and employment situations for an aboriginal worker. Thus, urban planning agencies cannot clearly identify their roles and functions in improving aboriginal employment in Taiwan.

This study used data form new aboriginal immigrants in Taipei County and applied

interviews, a questionnaire survey and various regression models to verify the relationships between job accessibility and employment for aboriginal workers. Empirical findings of this study contribute to literature in two ways. First, findings provide empirical evidence that does not exist in literature. Compared with previous job accessibility studies for a general population or minority groups, this study only provides knowledge about Taiwanese aborigines and identified unique relationships. For example, job accessibility did not significantly affect opportunities for employment or finding further stable jobs for aboriginal workers in urban areas, while car accessibility positively affected job salary, and transit or aggregate accessibility shortened commuting time.

Second, study findings provide a reference for city governments to develop employment improvement strategies for aborigines in urban areas. For example, this study found that increased accessibility to jobs decreased commuting time, employment in secondary and tertiary industries enhanced employment stability, secondary industry jobs provided high salaries and most respondents were employed in manufacturing, construction, social services and individual services. Thus, locating manufacture, construction and services jobs near aboriginal settlements via land-use zoning or providing industrial incentives can assist aborigines in finding stable well-paid jobs with low commuting costs.

Further investigations in aboriginal areas are needed to comprehensively identify the effects of job accessibility on aboriginal employment. An increasing number of aborigines are leaving their native homes and moving to urban areas. This continuous outward migration has decreased the vitality of aboriginal areas and is harmful to aboriginal culture. Seeking employment is one of the major reasons for this movement out of aboriginal areas. Few jobs exist in aboriginal areas as these areas are mostly rural and mountainous and have poor transportation service. Does job accessibility affect aboriginal employment in aboriginal areas? How different are accessibility effects on aboriginal employment between urban areas and aboriginal areas? Are there any effective strategies to improve job accessibility and keep aborigines in their native settlements? These questions warrant further explorations and could benefit the development of aboriginal areas in Taiwan.

Finally, major cities in Mainland China have attracted immigrants from rural areas in recent decades. Some immigrants are also ethnic minorities and may have experiences similar to those of Taiwanese aborigines moving to urban areas. Study findings may provide a reference to infer the relationships between accessibility and employment for ethnic minorities in China. Many studies have examined urban immigrants in China. For example, Huang *et al*. (2009) studied an urban immigrant community and urban development in Hangzhou. Zhang (2008) compared city immigrants in China, South Korea and Malaysia in terms of agglomeration economies. Song (2005) focused on cultural conflicts and social security. However, the relationships between job accessibility and employment for urban immigrants in China remain unexplored. Further investigations in Mainland China and comparisons with Taiwanese urban immigrants are worthy of study to understand the uniqueness of Chinese society.

Appendix

1. Binary logit models for explaining being employed

Explanatory variables	Base model		Expanded model	
	Coef.	p-value	Coef.	p-value
Constant	0.6484*	0.082	1.4827**	0.3774
Gender (male)	0.5709*	0.0811	0.6152*	0.0667
X_{edu1}	0.7886*	0.0683	0.8128*	0.0657
X_{edu2}	1.3449***	0.0019	1.4043***	0.0016
X_{edu3}	1.7926***	0.0011	1.8279***	0.0011
A_i^c	-	-	-4.7453	0.7989
A_i^m	-	-	-6.2100	0.7377
A_i^t	-	-	-9.7403	0.6257
A_i	-	-	5.6802	0.7593
Jobs within 5 km	-	-	-0.1759	0.5906
Walking distance to transit station	-	-	-0.1312	0.7092
LL(β_R)	-149.5367		-148.3823	
LL(β_0)	-157.5697		-157.5697	
ρ^2	0.0510		0.0583	
χ^2	16.0660***		18.3749***	
Likelihood ratio test	2.3088 ($\chi^2_{6,0.2} = 3.07$)			

*** significant at α=0.05, ** significant at α=0.1, * significant at α=0.2

2. Ordered logit models for explaining employment stability

Explanatory variables	Base model		Expanded model	
	Coef.	p-value	Coef.	p-value
Constant	-0.1624	0.5029	-5.1065	0.4703
Marriage	0.8366***	0.0001	0.8544***	0.0001
X_{edu2}	0.7546***	0.0008	0.8058***	0.0005
X_{edu3}	2.6739***	0.0000	2.6810***	0.0000
X_{occ1}	1.1415***	0.0000	1.1719***	0.0000
X_{occ2}	1.9999***	0.0000	1.9761***	0.0000
Job allowance	1.6819***	0.0000	1.6824***	0.0000
A_i^c	-	-	2.8351	0.4022
A_i^m	-	-	-1.2745	0.4734
A_i^t	-	-	-5.1162	0.4127
A_i	-	-	10.4342	0.4190
Jobs within 5 km	-	-	0.0001	0.7342
Walking distance to transit station	-	-	-0.0002	0.5122
LL(β_R)	-394.7773		-393.4183	
LL(β_0)	-492.6155		-492.6155	
ρ^2	0.1925		0.2014	
χ^2	192.6764***		198.3943***	
Likelihood ratio test	2.718 ($\chi^2_{6,0.2} = 3.07$)			

*** significant at α=0.05, ** significant at α=0.1, * significant at α=0.2

3. Linear regression models for explaining salary (GLS)

Explanatory variables	Base model			Expanded model		
	Coef.	t-value	VIF	Coef.	t-value	VIF
Constant	17259.245***	15.075	-	12770.183***	8.230	-
Gender (male)	5280.001***	5.651	1.146	45869.950***	4.658	1.292
X_{edu1}	-2380.757***	-2.297	1.131	-2636.413***	-2.560	1.141
X_{edu3}	5670.923***	4.913	1.299	5412.533***	4.714	1.315
X_{veh3}	17261.781***	11.651	1.348	17651.841***	11.971	1.366
Superintendent position	6524.906***	3.509	1.071	5891.794***	3.341	1.049
Work hours	91.507***	3.518	1.074	93.277***	3.569	1.078
X_{occ1}	18686.737**	1.953	1.173	2090.068***	2.173	1.180
Job allowance	2570.670***	2.795	1.072	2586.411***	2.838	1.077
A_i^c	-	-	-	14202.788***	2.503	1.024
F	F=70.732***			F=56.008***		
R^2	R^2=0.592 Adj-R^2=0.583			R^2=0.594 Adj-R^2=0.583		
D-W	1.881			2.006		
F statistic of model differences	0.5656 ($F_{2,345,0.2}$= 1.617)					

*** significant at α=0.05, ** significant at α=0.1, * significant at α=0.2

4. Linear regression models for explaining commuting time (OLS)

Explanatory variables	Base model			Expanded model		
	Coef.	t-value	VIF	Coef.	t-value	VIF
Constant	10.282***	10.163	-	18.156***	3.344	-
Gender (male)	3.413***	2.508	1.109	4.106***	3.020	1.144
Commuting distance	0.859***	20.161	1.075	0.839***	19.825	1.098
X_{tra1}	8.878***	3.261	1.070	9.528***	3.536	1.083
X_{tra2}	13.844***	4.216	1.084	14.325***	4.394	1.104
Transit headway	-	-	-	0.251***	3.452	1.067
A_i^c	-	-	-	11.614*	1.300	2.479
A_i^t	-	-	-	-64.176***	-2.004	1.347
A_i	-	-	-	-9.450*	-1.426	2.201
F	F=130.922***			F=69.578***		
R^2	R^2=0.599 Adj-R^2=0.595			R^2=0.617 Adj-R^2=0.608		
D-W	2.028			2.007		
F statistic of model differences	3.368*** ($F_{5,346,0.05}$=2.24)					

*** significant at α=0.05, ** significant at α=0.1, * significant at α=0.2

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