Job Accessibility Effects on Apartment Rentals

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Abstract

The previous studies applied the transaction price to explore the relationship between job accessibility and housing cost and concluded that transaction price and job accessibility are positively correlated. However, the transaction price has the investment demands that will result in the research bias. Consequently, housing rentals are further adequate in studying the issue while have not been well explored before. To fill the research gap, this study empirically investigated the job accessibility effects on apartment rentals using sample data in Taipei Metropolitan Area, Taiwan. This study examined the effects of job accessibility on apartment rentals for different sub-markets including building types and apartment types, different transportation modes and various rental levels. There are six hypotheses examined in this study. To examine the hypotheses, this study employed a gravity-type job accessibility index and used 7,077 observations in Taipei Metropolitan Area in 2009 as the study sample. The linear regression and quantile regression were both used to analyze the sample data.

The results show that general job accessibility was positively associated with apartment rentals. And, different building types and apartment types of sub-markets had different effects of general job accessibility on apartment rentals. Also, different job accessibility of transportation modes had different effects on apartment rentals of full sample. The empirical findings of this study make two important contributions to the literatures. First, this study presents new evidence regarding the effects of job accessibility on apartment rentals and the effects are significantly different among various sub-markets and transportation modes. Second, the findings of the present study provide a reference for governments in developing the policy of rental subsidies.

Keywords: Job accessibility; Apartment; Rental; Regression; Hedonic price function

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1. Introduction

Alonso (1974) argued that each citizen would pay the land rents based on different marginal benefits and costs when an urban is developed as a single-core structure. The location of the land would decide the land rent and transportation cost which are the factor of the marginal benefit and cost. The study results explained that transportation costs affect land rents. Most of the previous studies concluded that when a real estate is located in the urban core and it could cost lower transportation cost but higher land rent. Nowadays, most of cities are developed as a multi-core structure and transportation costs should be affected by not only distances to CBD but also commuting time between residences and work places. Therefore, some studies started to use indexes of "job accessibility" to measure transportation costs including distances, commuting costs and commuting time.

Adair *et al.* (2000) explored the relationships between accessibility and housing price. The study used hedonic models and employed an accessibility index and the sample of 2,648 residential properties in Belfast, Northern Ireland, which were transacted during 1996. The results proved the positive effects of accessibility on transaction prices and accessibility could be an important factor for housing price particularly in lower-income areas. Osland & Thorsen (2008) employed a study sample of 2,788 transaction observations and an accessibility index. The study results showed that transaction prices in CBD were significantly explained by labor market accessibility; and, the authors argued that the used accessibility measure didn't reduce the problems of spatial autocorrelation of commuting time.

Previous studies pointed out that accessibility has positive effects on housing transaction prices. However, after The Financial Tsunami in 2008, investors turned their capital to more stable investment targets, which include real estate markets, and have

resulted in elevated property prices worldwide in recent years. It's obvious that transaction prices are determined by investment demands and consumer demands and the previous studies which used "transaction prices" as land rents to discuss the issue of "the accessibility effects on real estate price" could be biased because of investment demands. Therefore, this study employed "rentals" as costs of residential real estates.

Furthermore, Carvero *et al.* (2002) used multinomial logit models to analyze the data of welfare recipients in California. In this article, the results showed that job accessibility of public transportation could explain accessing job opportunities better than accessibility of other transportation modes. Also, promoting public transportation developments could stimulate the employability of lower-income citizens. Grengs (2010) raised a contrary argument. This study used a census data of 2,000 observations in Detroit metropolitan area and a gravity-based model of job accessibility and showed positive relationships between car ownership and employability and incomes. Previous studies revealed that job accessibility could affect employment outcomes. In real estate market, different levels of incomes mean different affordability of housing rents.

Therefore, this study empirically analyzed the job accessibility effect on apartment rentals to review the relationship between job accessibility and housing costs. Also, this study used different transportation modes of job accessibility to examine the effects on different kinds of building types and apartment type.

2. Methodology and Design

This section first specifies the study hypotheses, then focuses on the outcome measure and possible factors affecting the study outcome. Subsequently, model specification and the analytical methods are described.

Hypotheses

According to references, this study proposed the following six hypotheses.

H1: job accessibility positively affects apartment rentals.

H2: the effects of job accessibility on apartment rentals are different among various transportation modes.

H3: the effects of job accessibility on apartment rentals are different among various building types.

H4: the effects of job accessibility on apartment rentals are different among various property types.

H5: the effects of job accessibility on apartment rentals are different among various rental levels.

H6: the impact of job accessibility of public transportation modes on apartment rentals is greater than the impact of job accessibility of private transportation modes on apartment rentals.

Study variables, model and the analytical methods

Various explanatory variables have been used to explain property rentals in previous studies. Marks (1984), Guntermann & Norbin(1987), Sirmans *et al.*(1989) and Lin(1993) examined the number of bedrooms, the rental area and the house age. Lin (1993) examined the number of kitchens, the building types and the apartment types. Marks (1984) examined the located floor. Sirmans *et al.* (1989) examined the distance to railways and stations. Guntermann & Norbin(1987) and Sirmans *et al.*(1989) examined the distance to main roads.

This study adopted the above-mentioned factors as independent variables and classified them into internal and external features as listed in Table 1.

This study applied linear regression and quantile regression models to examine the hypotheses. Eq. (1) is the linear regression model for the full sample. Eq. (2) is the quantile regression model for the full sample. All of the definitions of explanatory

variables are listed in Table 1.

On the other hand, this study examined hypotheses by T-test (See Eq. (3)). For the hypothesis 1, this study observed the coefficients of job accessibility variables in Eq. (1). For the hypothesis 2, this study used the T-test to examine the differences of job accessibility effects on apartment rentals among various transportation modes. For the hypothesis 3 and 4, this study used the T-test to examine the differences of job accessibility effects on apartment rentals among various building types and apartment types. For the hypothesis 5, this study used the T-test to examine the differences of job accessibility effects on apartment rentals among various rental levels. For the hypothesis 6, this study compared the standard coefficients of job accessibility effects of private transportation modes with the standard coefficients of job accessibility effects of public transportation modes.

Table 1 Explanatory variable list

Classification	variables	notations	measurements
Internal Features	apartment type	H_{style1}	1 denotes suite. 0 denotes others.
		H_{style2}	1 denotes room. 0 denotes others.
	building type	H_{arch}	1 denotes elevator apartment. 0 denotes others.
	bedroom	H_{room}	1 denotes having 1 bedroom. 0 denotes others.
	kitchen	H_{kit}	1 denotes having 1 kitchen. 0 denotes others.
	restroom	H_{toi}	1 denotes having 1 restroom. 0 denotes others.
	located floor	H_{floor1}	1 denotes the first floor. 0 denotes others.
		H_{floor2}	1 denotes above the 16th floor. 0 denotes others.
	house area	H_{area}	Measurement Unit: Pin=3.3

Classification	variables	notations	measurements
			m^2
	house age	H_{year}	Measurement Unit: year
External Features	housing demand of labours	H_{region}	(workers / population) × 100
	distance to main road	H_{rdis}	Measurement Unit: meter
	distance to bus stop	H_{busdis}	Measurement Unit: meter
	distance to the station	H_{rsdis}	Measurement Unit: meter
	distance to the railway	H_{rldis}	Measurement Unit: meter

$$\ln RP_{all} = \beta_0 + \beta_1 JA_{all} + \beta_2 H_{style1} + \beta_3 H_{style2} + \beta_4 H_{arch} + \beta_5 H_{room} + \beta_6 H_{kit} + \beta_7 H_{toi} + \beta_8 H_{floor1} + \beta_9 H_{floor2} + \beta_{10} H_{area} + \beta_{11} H_{year} + \beta_{12} H_{rdis} + \beta_{13} H_{busdis} + \beta_{14} H_{rsdis} + \beta_{15} H_{rldis} + \beta_{16} H_{region} + \varepsilon \quad (1)$$

where RP_{all} is rentals.

$$\mathrm{Q}(\ln RP_{all} \mid X_i, \theta) = \beta_0^\theta + \beta_1^\theta JA_{all} + \beta_2^\theta H_{style1} + \beta_3^\theta H_{style2} + \beta_4^\theta H_{arch} + \beta_5^\theta \beta_5 H_{room} + \beta_6^\theta H_{kit} + \beta_7^\theta H_{toi} + \beta_8^\theta H_{floor1} + \beta_9^\theta H_{floor2} + \beta_{10}^\theta H_{area} + \beta_{11}^\theta H_{year} + \beta_{12}^\theta H_{rdis} + \beta_{13}^\theta H_{busdis} + \beta_{14}^\theta H_{rsdis} + \beta_{15}^\theta H_{rldis} + \beta_{16}^\theta H_{region} + \varepsilon \quad (2)$$

$$t = \frac{|\hat{\beta}_{c1} - \hat{\beta}_{c2}|}{S_{\hat{\beta}_{c1}}} > t_{n-k-1,\alpha/2} \quad (3)$$

where $\hat{\beta}_{c1}$ and $\hat{\beta}_{c2}$ are coefficient, $S_{\hat{\beta}_{c1}}$ is the standard error of c1.

3. Data

There are two parts of data in this study. The first is about job accessibility. Based on the data from Department of Rapid Transit Systems (2012), this study used the generalized cost in 2009 to calculate the impedance function (gamma function). Then, using the data of employees, workers and impedance functions of traffic analysis zones, the general job accessibility and different modes of job accessibility were defined and measured by. (Eq. (4)-(7))

$$JA_{all}^{i}=\sum_{j}\frac{E_j\times f\left(C_{all}^{ij}\right)}{\sum_{k}\left\{a_kW_{k(t)}\times f\left(C_{all}^{kj}\right)+\beta_kW_{k(t)}\times f\left(C_{all}^{kj}\right)+\gamma_kW_{k(t)}\times f\left(C_{all}^{kj}\right)\right\}}\text{.....（4）}$$

$$JA_{car}^{i}=\sum_{j}\frac{E_j\times f\left(C_{car}^{ij}\right)}{\sum_{k}\left\{a_kW_{k(t)}\times f\left(C_{car}^{kj}\right)+\beta_kW_{k(t)}\times f\left(C_{motor}^{kj}\right)+\gamma_kW_{k(t)}\times f\left(C_{pub}^{kj}\right)\right\}}\text{.....（5）}$$

$$JA_{motor}^{i}=\sum_{j}\frac{E_j\times f\left(C_{motor}^{ij}\right)}{\sum_{k}\left\{a_kW_{k(t)}\times f\left(C_{car}^{kj}\right)+\beta_kW_{k(t)}\times f\left(C_{motor}^{kj}\right)+\gamma_kW_{k(t)}\times f\left(C_{pub}^{kj}\right)\right\}}\text{.....（6）}$$

$$JA_{pub}^{i}=\sum_{j}\frac{E_j\times f\left(C_{pub}^{ij}\right)}{\sum_{k}\left\{a_kW_{k(t)}\times f\left(C_{car}^{kj}\right)+\beta_kW_{k(t)}\times f\left(C_{motor}^{kj}\right)+\gamma_kW_{k(t)}\times f\left(C_{pub}^{kj}\right)\right\}}\text{.....（7）}$$

where JA_{all}^{i} is the zone *i* of general job accessibility, JA_{car}^{i} is the zone *i* of job accessibility of car modes, JA_{motor}^{i} is the zone *i* of job accessibility of motorcycle modes, JA_{pub}^{i} is the zone *i* of job accessibility of public transportation modes, E_j is the zone *j* of employees, W_k is the zone *k* of workers, a_k is the zone *k* of proportion of car modal split. β_k is the zone *k* of proportion of motorcycle modal split. γ_k is the zone *k* of proportion of public transportation modal split. $f\left(C_{car}^{ij}\right)$ is impedance functions of car modes between zone *i* to zone *j*. $f\left(C_{motor}^{ij}\right)$ is impedance functions of motorcycle modes between zone *i* to zone *j*. $f\left(C_{pub}^{ij}\right)$ is impedance functions of public transportation modes between zone *i* to zone *j*.

The second type is about the rental sample. The reason for choosing the Taipei Metropolitan Area (Taipei City and New Taipei City) as the empirical region is that Taipei has 25.9% investment demands in residential housing market, which is the highest proportion of investment demands in Taiwan (Construction and Planning Agency, 2011) . Therefore, this study deleted some districts which connect nearby cities. Then, the sampling areas include partial districts in New Taipei City and all districts in Taipei City as shown in Figure 1.

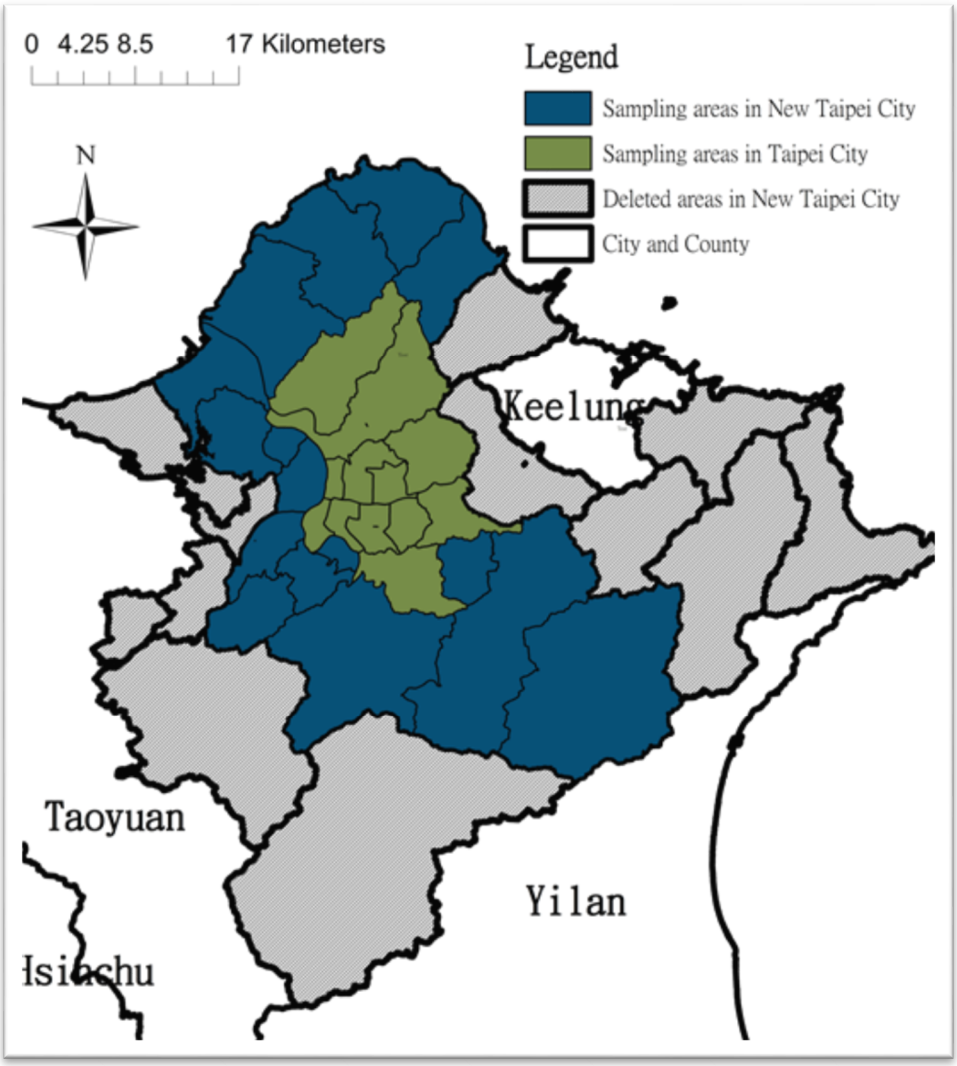


Figure 1. The sample areas

Table 2 presents rental descriptive statistics for various models. The number of entire observations in 2009 is 7,077 and the average rental is 962 NTD/Pin. The number of observations equipped with elevators is more than that of non-elevator observations. According to the observations of different building types, Table 2 reveals that the average rental of elevator observations is more expensive than that of non-elevator observations. According to the observations of different apartment types, Table 2 reveals that the average rental of suites is more expensive than that of single rooms. The average rental of multi-room observations is the cheapest because that areas were commonly larger than other apartment types.

Table 2. Rental Descriptive Statistics

Rental (NTD / Pin)	Model A (full sample)	Model B-1		Model B-2		
		Elevator	Non-elevator	suite	Single room	Multi-room
Number of Obs.	7077	4428	2649	3349	162	3566
Maximum	2,909	2,909	2,300	2,909	1,857	2,500
Minimum	200	200	300	292	571	200
Average	962	972	945	1,145	1,114	793
Medium	925	925	919	1,115	1,100	789
Std. Deviation	266.655	270.462	259.350	223.940	210.288	186.187
Coefficient of Variation	0.277	0.278	0.275	0.198	0.189	0.235

4. Results

The job accessibility variables were analyzed using six models by linear regression method. For each model, only control variables, coefficients were estimated in the beginning, of the variables with insignificant coefficients or VIF values above 5, were removed from models. After that, the job accessibility variables were added into expanded models.

Table 3 lists the linear regression results of the general job accessibility effects on rentals. Table 4 lists the linear regression results of job accessibility effects of different transportation modes on rentals. The *Adj* R^2 show that accessibility variables of car, motorcycle and public transportation all improved the goodness-of-fit for all models. It means that job accessibility variables of different transportation modes are important in explaining apartment and rentals.

The estimated signs of partial control variable are different from the expected signs. Such as the distance to main roads and the distance to bus stops, both empirical results present that both factors were external costs for the demanders of both market. The empirical results of housing demand of labour mean that renters tended to live in the community where provided low-rent apartments.

Table 3 and table 4 reveal that only general job accessibility of the suite

observations negatively affected rentals. Gobillon & Selod (2007) concluded that job accessibility negatively affects apartment rentals because higher income or educated citizens rejected to live with lower income or educated citizens who would cluster in the areas of higher job accessibility to get more job opportunities. Therefore, the average price of suite observations is higher than other types of apartment and it means that the renters of suites could afford higher rentals and choose the community, which is far from the area with higher job accessibility.

Through the T-tests using coefficients and standard errors of table 1 and table 2, the results supported the hypotheses 1, 2 and 3. Besides the results of the job accessibility effects of public transportation on the rentals of multi-room and single-room, other results supported the hypotheses 4.

Table 3. Linear Regression Result

Variables	Model A-1	Model B-1		Model B-2		
		Elevator	Non-elevator	suite	Single room	Multi-room
Adj R^2	0.493	0.457	0.374	0.122	0.167	0.168
Apartment type 1	0.290^{***}	0.285^{***}	X			
Apartment type 2	0.249^{***}	0.220^{***}	X			
Building type	0.022^{***}			X	X	0.073^{***}
Bedroom	X	X	X	X	0.145^{*}	X
Kitchen	0.042^{***}	0.065^{***}	-0.331^{***}	0.059^{***}	X	X
Located foor 1	X	X	X	X	X	0.039^{*}
Located floor 2	X	X	X	X	X	-0.087^{*}
House area	-0.089^{***}	-0.069^{***}	X	-0.111^{***}	-0.140^{***}	-0.053^{*}
House age	-0.011^{***}	-0.011^{***}	-0.003^{***}	-0.026^{***}	X	X
Distance to main road	X	$-6.204\times10^{-5***}$	0.007^{*}	0.010^{***}	-0.026^{*}	-0.001^{*}
Distance to bus stop	X	$1.850\times10^{-7**}$	X	X	X	$6.348\times10^{-5*}$
Distance to station	-0.003^{***}	-0.003^{***}	0.005^{***}	-0.003^{***}	$-3.241\times10^{-5***}$	-0.003^{***}
Housing demand of labours	-0.073^{***}	-0.096^{***}	X	-0.072^{***}	X	-0.069^{***}
General job accessibility	0.011^{***}	0.016^{***}	X	$-5.431\times10^{-6*}$	X	0.034^{***}

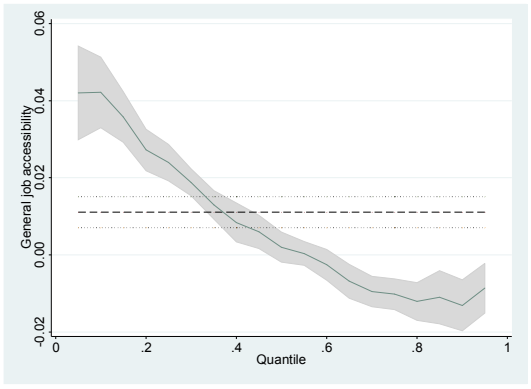
*** denotes statistical significane at 0.5% level. ** denotes statistical significane at 1% level. * denotes statistical significane at 5% level.The gray grid denotes the estimated sign is different from the expected sign. X denotes insignificant results or VIF value above 5.

Table 4. Linear Regression Result

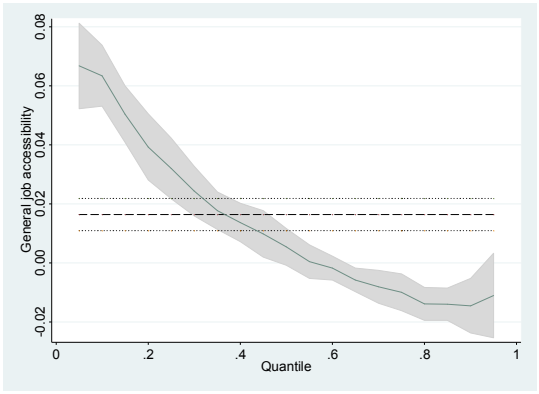
	Model A-1	Model B-1		Model B-2		
		Elevator Building	Non-elevator Apartment	Studio	Room	House
Adj R^2	0.579	0.545	0.433	0.263	0.317	0.325
Job accessibility of car (standard error)	0.020^{***} (0.000794)	0.022^{***} (0.001086)	0.015^{***} (0.001446)	0.010^{***} (0.001082)	0.019^{***} (0.003884)	0.030^{***} (0.001172)
Job accessibility of motorcycle (standard error)	0.005^{***} (0.000254)	0.006^{***} (0.000350)	0.004^{***} (0.000485)	0.007^{***} (0.000346)	X	0.003^{***} (0.000368)
Job accessibility of public transportation (standard error)	0.003^{***} (0.000553)	0.002^{**} (0.000745)	X	0.004^{***} (0.000777)	X	X

*** denotes statistical significane at 0.5% level. ** denotes statistical significane at 1% level. * denotes statistical significane at 5% level.The gray grid denotes the estimated sign is different from the expected sign. X denotes insignificant results or VIF value above 5.

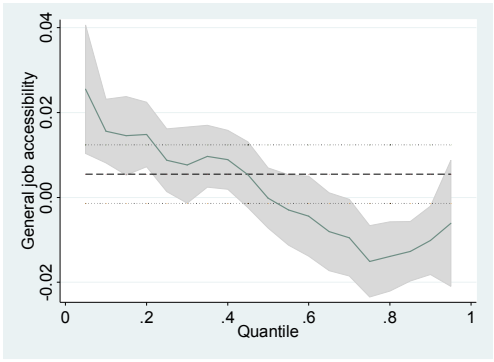
Figure 2 shows general job accessibility effects on rentals for different rental quantiles. Besides the model B-1 elevator observations, most of the quantile regression models describe that job accessibility positively affected lower rentals and negatively affected higher rentals. The effects of job accessibility between rentals 0.75 quantiles and 0.9 are different. It concluded that the results partially supported the hypothesis 5.



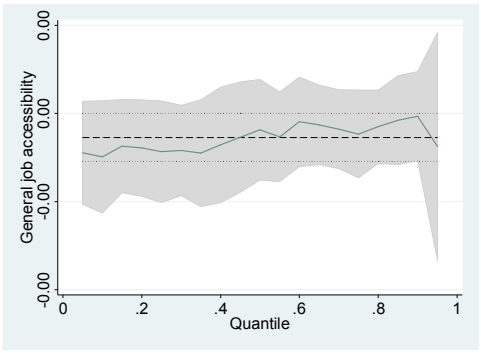
Model A-1



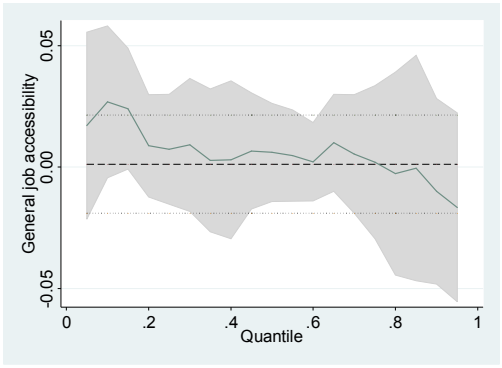
Model B-1 Elevator



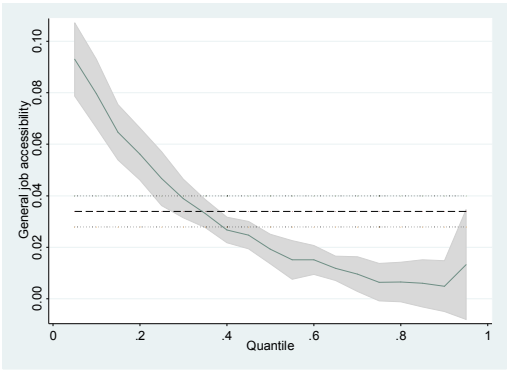
Model B-1 Non-elevator



Model B-2 Suite



Model B-2 Single Room



Model B-2 Multi-room

Figure 2. Quantile regression for the coefficient of general job accessibility

Table 5 points out that the impact of job accessibility of private transportation effect on rentals is greater than job accessibility of public transportation effect on rentals. Besides the studio type, other models show that the impact of job accessibility effect by motorcycle on rentals is greater than the impact of job accessibility effect by car on rentals. It concluded that the study rejected the hypotheses 6.

Table 5. Standard coefficients of job accessibility of different transportation modes

Standard Coefficients	Model A-1	Model B-1		Model B-2		
		Elevator	Non-elevator	Suite	Single room	Multi-room
Number of Obs.	7077	4428	2649	3349	162	3566
Job accessibility of motorcycle	0.221***	0.238***	0.181***	0.166***	0.479***	0.406***
Job accessibility of car	0.172***	0.180***	0.144***	0.309***	0.126	0.118***
Job accessibility of public transportation	0.052***	0.033**	0.029	0.081***	0.012	0.024

*** denotes statistical significane at 0.5% level. ** denotes statistical significane at 1% level.

5. Conclusions

This study used “rental” as a measure of housing cost to examine the job accessibility effects on housing cost. Previous studies haven’t used rentals as housing costs to examine the job accessibility effects on housing costs, and haven’t discussed the differences job accessibility effects on housing costs among different transportation modes, property types and rental levels.

In this study, there are five important conclusions. First of all, job accessibility would positively affect rentals besides the sub-market of suite. Second, different transportation modes would have different job accessibility effects on rentals. Third, job accessibility would have different effects on rentals of different building type sub-markets. Forth, higher rentals will be negatively affected by job accessibility. Finally, the job accessibility effects of private transportation modes on rentals are greater than that of public transportation modes in Taipei Metropolitan Area.

According to the conclusions, governments could formulate the policies of rental subsidy more precisely and efficiently. Based on the targets of the development of public transportation and reducing financial burdens, the policy of rental subsidy could aim at renters who use public transportation systems.

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