RAIL ACCESSIBILITY ON PROPERTY VALUE: ZUOYING STATION

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STRUCTURED ABSTRACT

Problem/Purpose: Accessibility to transport infrastructure is one of the factors that affects property value. A number of researchers have found positive and negative effects on how improvement in public transportation has on property value (Chau and Ng, 1998). In Taiwan, little research has been carried out in this area. This research seeks to contribute to the understanding of the effect of rail accessibility on property value. Specifically, this study investigates the impact on property value located in close proximity to Zuoying station in Taiwan. Hedonic price theory is used and 5,478 data sets including property transaction prices, house or unit size; distances to the rail station, amenities, parklands and main roads were used for the testing. Before and after the commencement of the rail systems has also been considered in this study.

Design/methodology/approach: Hedonic analysis is a well-established technique that is applied in this study.

Findings: The estimation results suggest that accessibility to train station is one of the important factors affecting property values. It is found that the shorter distance and easier access the rail station, the higher the property values.

Research limitations/implications (if applicable): This research has considered the elements of before and after the opening of the Taiwan High Speed Rail (THSR) and Kaohsiung Mass Rapid Transit (KMRT). However, a comparison study on the effects of before and after the completed rail development is not included in this study.

Takeaway for practice (if applicable)

Originality/value: No study has been conducted in the past on Zuoying station in the area of rail accessibility and property values. This is the only rail station in southern Taiwan where three railway systems converge. The investment of new transport infrastructure has positive impact on the land values in the locality and the economic and social aspects of the built environment.

Social Implications (if applicable):

Keywords: Rail accessibility, property value, Kaohsiung, Taiwan

INTRODUCTION

Kaohsiung is a global city located in south-western coast of Taiwan with a total area of 2,947.62 square kilometres. The population in Kaohsiung is the second largest in Taiwan after New Taipei city with 2.78 million people as of June 2014. This represents a 45.3 per cent increased in seven years from 1.52 million in 2007. Kaohsiung has a large international cargo port and is also an Industrial city with business in steel manufacturing, ship building, petrochemical and oil refinery, aluminium and cement works, and other related industries. The public transportation systems have been developed over the years to meet the population growth and economic development. In addition to the highways, there are three main public transportation systems in Kaohsiung, namely, Taiwan Rail Administration (TRA), Taiwan high speed Rail (THSR) and Kaohsiung Mass Rapid Transit (KMRT). The TRA circuits the island taking passengers to all major cities in Taiwan; whereas the THSR is direct trains departing from Kaohsiung to major cities in central and northern Taiwan. It provides three to four trains per hour and takes merely one and half hours from Kaohsiung to

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Taipei. The KMRT is a system crossing Kaohsiung city and neighbouring cities and towns. The north-south red line and east-west orange line provide passengers accessing to and from the hinterland metropolitan Kaohsiung area. Zuoying is the only rail station in southern Taiwan where three rail systems converge. There are over 64,000 passengers who use the three rail systems daily according to the monthly statistics from the Transportation Bureau, Kaohsiung City Government (2015). The THSR was completed in January 2007 whereas the two mass transit lines of KRTS were completed in September 2008.

The improvement of transport infrastructure in Kaohsiung not only provide conveniences for commuters to travel across the three rail systems merging into Zuoying station, but also boost population growth and stimulate the local economy. According to Taiwan Census (2015), the resident population increased by 12 per cent in Kaohsiung City from 2,756,775 people by the year end 2000 to 2,777,384 people by the year end 2010 after the rails systems were built. The real estate market in Kaohsiung also boomed after the introduction of the new rail systems although Taiwan's real estate market declined and went into deep recession as a result from the global financial crisis (Huang, et al., 2011). Figure 1 depicts the rail systems at the Zuoying station.

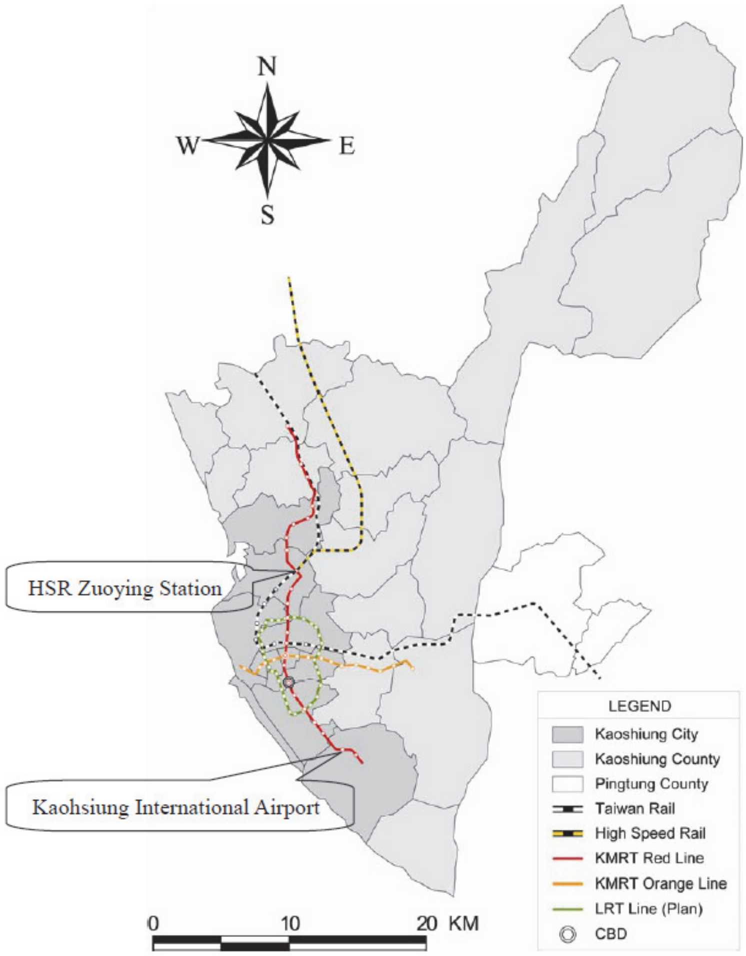

Figure 1: The Public Transport Network in Kaohsiung Metropolitan Area (Source: Huang, et al., 2011)

The new transport infrastructure improves accessibility and has positive influences on housing values. The closer and easier access transport services, the higher the demand for the location and higher the housing values. On the other hand, housing values could be decreased as a result of unavoidable busy and noisy environments surrounding the infrastructure because a large amount of people use rail system daily. This research seeks to contribute to the understanding of the effects of the rail accessibility on property value for Taiwan's Zuoying station. Hedonic model is used and 5,478 data sets including property transaction prices, house or unit size; distances to the rail station, amenities, parklands and main roads were used for the analysis. Before and after the commencement of rail systems has also considered in this study. Next section reviews literature on rail accessibility and housing value. Research methodology including data used will be presented and research findings will be discussed at the end.

ACCESSIBILITY AND PROPERTY VALUE

Property value consists of land value and building value. Building values can be influenced by the type of buildings, building age, number of bedrooms, gross floor area and other building related features; whereas land value is usually appreciated due to scarcity of land available for accommodating the increased demand for housing. Land is also immobile thus where the land located implies its unique feature and value. Accessibility to transportation and amenity is one of the aspects of location. The relationship between accessibility and housing values has been studied extensively in many national settings. The early theories developed by Alonso (1964) and Muth (1969) who proposed a trade-off theory, i.e., an inverse relationship between travel costs from and to CBD and the rent of a land. Maclennan (1982) found that property values are influenced by location, neighbourhood, and racial, historical, physical and structural factors. The factors such as the distance from CBD, house and lot size and local environment amenities were also considered by Abelson (1997) in estimating property value.

There have been substantial studies on the impact of transportation investment on land value. Examples are Alcaly (1976); Coulson and Engle (1987); Forrest, et al. (1992); Hess and Almeida (2007); Immergluck (2009); Debrezion, et al. (2011). The effects of transportation investment were identified as a) improving accessibility; b) lower transportation costs; c) higher property value; and d) changing local economy and development pattern. Yin, et al. (2014) studied the effects of the high-speed railway (HSR) network on cities at the regional, urban and station-area level in China. They found that reduced travel time and integrated transport system were the main benefits of transportation investment.

Rail accessibility affects property value because of lower commuting costs. Bowes and Ihlanfeldt (2001) researched of Georgia in the United States and found that stations that are located sufficiently far away from the urban core tend to attract new residential development. They also found that retail activity was attracted from localities further away from stations, other things being equal. However, negative externalities such as noise and better access for criminals were identified for the areas. By studying the South Yorkshire Supertram using hedonic method, Henneberry (1997) advised that property value could be influenced by the changes in accessibility induced by new transport infrastructure and long-run social, technological and economic trends.

Studies of the regional enlargement of the Stockholm region in Sweden (Andersson and Andersson, 2008) showed that the radius of the price-distance gradient increased as a result of improved rail accessibility. They concluded that residential property prices in Uppsala could be partly explained by shorter the travel time after the introduction of a frequent 45-minute commuter train service with discounted fares for daily commuters from Stockholm. Martínez and Viegas (2015) examined the relationship between the availability of transportation infrastructure and the pattern of house prices in an urban area and residential property values in the metropolitan area of Portugal. They suggested that there are significant property value changes at the proximity to one or two metro lines.

Negative effects of infrastructure investment on property value were found. Chen, et al., (1998) claimed that homes close to a rail line may suffer the dis-amenity of noise, which will be outweighed for properties close to stations by the amenity of accessibility. In Hong Kong, Chau and Ng (1998) examined the effects of the electrification of the Kowloon-Canton Railway (KCR) in 1983 on the price gradient of residential properties between two areas namely, Sha Tin and Tai Po, connected by the railway. They found that improvement in public transportation has a negative effect on the price gradient along the railway line. They also suggested that the use of linear specification of the hedonic equation produced similar results as the flexible Box-Cox specification. Similarly, Adair, et al., (2000) researched the factors affecting the price structure of residential property in the Belfast Urban Area and found that accessibility played a little significance in explaining variation in house prices at a city-wide scale but at a sub-market level, particularly in lower-income areas, accessibility can be an important influence.

In Taiwan, Lin and Hwang (2004) presented a comparison study of changing in property values along the corridor on the before-and-after the opening of the Taipei subway system. Floor space, building age and distance from public facilities were found significantly changes after subway opening. No study has been conducted previous on the accessibility and property value at Zuoying station where three rail systems converged. Next section discusses the research methodology and data sources.

METHODOLOGY, DATA AND ESTIMATED RESULTS

Many of the previous literature applied hedonic price theory – characteristics function developed by Rosen (1974) – in studying the relationship of accessibility and property value (Chau and Ng, 1998; Lin and Hwang, 2004; Debrezion, et al., 2011). Hedonic pricing implies a good is associated with a package of inherent attributes using multiple regression techniques. In measuring property value attributes, researchers typically treat sale prices as a function of building attributes, environment attributes and macroeconomic factors (Lin and Hwang, 2004). In this study, macroeconomic factors have not included since only one station Zuoying is studied. Following equation is used to estimate using regression technique.

$$LRPrice = \beta_0 + \beta_1 \mathrm{LSize} + \beta_2 \mathrm{LView} + \beta_3 LPark + \beta_4 LRoad + \beta_5 LDistance + \beta_6 LArea + \beta_7 BA\_THSR + \beta_8 BA\_KRTS + \varepsilon$$

Where β_0 is the constant, β_i (for i = 1, 2, 8) is the regression coefficients, and ε is a random element that reflects the unobserved variations in the property values (*LRPrice)*.

LRPrice is property transaction prices used to represent the property values in Taiwan currency ($NT). The prices were collected from the Department of Land Administration, Ministry of the Interior in Taiwan (2015). In this regression analysis, *LRPrice* is a dependent variable which is converted to the real term by deflating Consumer Price Index (CPI) (December 2013 = 100).

LView and *LPark* measure the distance to amenity. *LView* is the direct distance from a property to see a view measured by meters; whereas *LPark* is the direct distance from a property to a park measured by meters. A geographic information system (GIS) is applied to obtain the distance data. It is expected that the longer the distance to access views or a park, the lower the property values. The shorter the distance to access views and a park, the higher the value of the property.

LDistance represents the direct distance from a property to the rail station measured by meters. The distance is also derived by GIS. A negative correlation between the distance to rail station and property values is expected. A longer the distance a property to the rail station, a longer the time required to access the rail facility, the lower the value of the property. Conversely, a property value is expected higher where the property is within walking distance to rail station.

LRoad measures the width of the roads, streets or laneways that a property can access. The distance from a property to a road or a street is derived from GIS. The biggest main road in Kaohsiung is 40 meters in width that consists of 8 traffic lines. A property faces a main road has to bear the noisy from busy traffic. The property value is expected lower as it is located close to the main road. Some properties are located at quiet streets. For example, laneways have only 3 meters in width and thus less busy and traffic on the laneways. Properties located at the quiet living environment thus are expected higher the values.

Both *LArea* and *LSize* were collected from the Department of Land Administration, Ministry of the Interior in Taiwan (2015). The data is measured by square meters. *LArea* is defined as the land areas where properties are located; whereas *LSize* shows the gross floor area of a house or unit. Statistics suggest that a positive correlation between the property value and land areas (*LArea*) and house or unit sizes (*LSize*). The larger the land areas, the higher the property values. Similarly, the bigger the house or unit sizes, the higher the property values. It should be noted that 'number of bedrooms and bathrooms' were not included in this analysis since their effect would have overlapped with the size of the house or unit.

BA_THSR and *BA KRTS* denote the before and after the opening of the Taiwan High *S*peed Rail (THSR) and Kaohsiung Mass Rapid Transit (KMRT). They are dummy variables in this study and denoted 'before = 0' and 'after = 1'. The sign of the estimated value can be positive or negative depending on whether the new rail investments have effects on property markets and values.

Table 1 summaries the variables, expected sign and data sources; as well as the basic statistics of the variable used for the regression analysis. A total of 5479 data sets from 2^{nd} quarter of 2000 to 1^{st} quarter of 2015 were collected for this study. All collected variables are converted to natural logarithms before applying SPSS to derive the models. Thus, the associated estimators of variables present the corresponding price elasticities.

Table 1: Variable defined and basic descriptive statistics

Symbol (Log)	Expected Sign	Description	Number	Minimum	Maximum	Mean	Std. Deviation	Data Source
LRPrice		Property transaction Price ($NT)	5478	2.940	8.490	6.819	0.304	Dept. of Land Administration, Ministry of the Interior in Taiwan
LSize	Size (+)	Gross floor areas (sqm)	5478	0.000	3.170	3.200	0.160	Dept. of Land Administration, Ministry of the Interior in Taiwan
LDistance	Accessibility (-)	Distance to Rail Station (meter)	5478	1.990	3.180	2.956	0.190	GIS
LPark	Accessibility (-)	Distance to Park (meter)	5478	1.630	3.270	2.849	0.312	GIS
LRoad	Accessibility (-)	Road types and width: Main Road, Street, Laneway. etc. (meter)	5478	0.300	1.600	1.246	0.249	GIS
LView	Accessibility (-)	Distance to View (meter)	5478	1.670	3.450	3.210	0.160	GIS
LArea	Area (+)	Land area of the property (Sqm)	5478	0.760	3.340	2.156	0.207	Dept. of Land Administration, Ministry of the Interior in Taiwan
BA_THSR	(+) or (-)	before = '0', after = '1'	5478	0.000	1.000	0.943	0.232	Dummy
BA_KRTS	(+) or (-)	before = '0', after = '1'	5478	0.000	1.000	0.926	0.262	Dummy

The criteria for assessing the statistical significance of derived models are based on the Adjusted-R-Square, *F-test*, and Durbin–Watson (DW), *t-test* and Variance Inflation Factor (VIF). The higher the Adjusted-R-Square, the higher the explanatory power of the derived model. The VIF shows the severity of multicollinearity in the ordinary least squares regression analysis. There is a high multicollinearity if VIF is larger than 10. The DW detects the presence of autocorrelation in the residuals from a regression analysis. When DW equates or closes to 2 that indicates no autocorrelation.

Four derived hedonic regression models are shown in Table 2. In all cases, all estimated coefficients are significant at the 0.5 per cent level. All the independent variables are consistent with the expected signs and have values significantly different from zero in *t-test*. The coefficients of *LArea* and *LSizes* indicate positive and statistical significant. These results suggest that property value increases when the size of houses or units increases. On the other hand, the coefficients of *LDistance*, *LRoad, LView and LPark* indicate negative sign and statistical significant. These results imply that property value could decline where longer the distance from the property to rail facilities and amenities. The two dummy variables, 'before-' and 'after-' opening of THSR and KRTS show positive sign and statistical significant, meaning that property value increased after the opening of THSR and KRTS. The Adjusted-R-Square of the four models is around .70 estimated. This finding is consistent with the literature (Henneberry, 1998; Adair, et al., 2000). All the VIF values are below 10 indicates that no significant collinearity exists among the independent variables. The DW tests also show no serial correlation exists in the studied samples.

Model 1 consists of variables of *LArea, LView, LPark and BA_THSR* that are statistical significant. A one per cent increase of property area is associated with 1.235 per cent increase in property value. A one per cent further away from views and parklands is associated with 0.101 and 0.03 per cent decrease in property value respectively. In addition, a 0.086 per cent increases in property value after the opening of *THSR*. This suggests that the new developed Taiwan High Speed Rail (THSR) pushed the property price up in Kaohsiung. Model 2 produces similar results that the bigger the land area of a property, the higher the value of the property. The results also show that the accessibility to views and parklands contributes to the level of property values. In addition, it is suggested a 0.068 per cent increases in property value when KRTS was completed.

Variables that show statistical significant in the Model 3 are *LArea, LDistance, LRoad, and BA_KRTS*. Comparing to Model 1 & 2, a similar result is produced for the variable *LArea*. A one per cent shorter the distance to the rail station leads to 0.038 per cent higher in property value. In addition, for properties one per cent closer the main road induces to 0.02 per cent decrease in property value. After KRTS operated, property values also rise by 0.095 per cent. All the independent variables in Model 4 are the same as Model 3 except the opening of THSR increases of 0.102 per cent in property value.

Table 2: Regression results

	Model 1				Model 2				Model 3				Model 4			
	Coefficients	**t-value**	**Sig.**	**VIF**	**Coefficients**	**t-value**	**Sig.**	**VIF**	**Coefficients**	**t-value**	**Sig.**	**VIF**	**Coefficients**	**t-value**	**Sig.**	**VIF**
Dependent variable	LRPrice				LRPrice				LRPrice				LRPrice			
Independent variables																
Constant	4.487	67.263	.000		4.445	66.899	.000		4.177	89.132	.000		4.178	88.629	.000	
LArea	1.235	112.277	.000	1.027	1.243	112.986	.000	1.038	1.247	113.50	.000	1.029	1.243	113.463	.000	1.022
LDistance									-0.038	-3.164	.000	1.009	-0.037	-3.153	.000	1.010
LSize																
LRoad									-0.020	-2.176	.000	1.006	-0.021	-2.282	.000	1.005
LView	-0.101	-6.733	.000	1.140	-0.102	-8.859	.000	1.140								
LPark	-0.030	-3.879	.000	1.149	-0.027	-3.902	.000	1.151								
BA_THSR	0.086	8.495	.000	1.030	0.040	2.045	.041	4.112					0.102	10.396	.000	1.027
BA_KRTS					0.068	3.902	.000	4.148	0.095	10.915	.000	1.034				
Adjusted-R-square	0.702				0.706				0.703				0.703			
F-test	3233				2623				3246				3237			
Significance	.000				.000				.000				.000			
DW	1.765				1.615				1.622				1.619			
Sample size	5478				5478				5478				5478			

DISCUSSION AND CONCLUSION

This study adds to the growing literature on the relationship between new rail investment and property values. Given the collected samples in Kaohsiung, the analysis in this study using hedonic pricing method produced three findings: a) the larger the house or unit size the higher the property value; b) the proximity to rail, main road, parklands or views influences property value; and c) infrastructure investment adds property value. In specific, an inverse relationship between a property's distance from rail station and its value suggests that better accessibility to new transit services had positive effects on property value appreciation. This result confirms with previous studies (Henneberry, 1998; Adair, et. al., 2000) and suggests a significant benefit of location. That is that households live nearby the rail systems allow them to transit freely and timely to any of the rail lines at Zuoying station, and to travel daily to Taipei for working is also possible for those households in need.

In addition, an inverse relationship between a property's distance to the public facilities, such as parklands and views and their values implies that accessibility plays an important role on the level of property values. Another interesting finding from this research is that a negative correlation between the property values and the road types and width. This result shows that properties close to a main road may suffer the dis-amenity of constant noise from traffics and property value could be affected. Furthermore, the opening of new rail facilities influences property value positively that indicates that infrastructure investment benefits of its surrounding property values. However, it should be noted that changes in accessibility induced by new transport infrastructure are not the only influence on property values. Other variables such as macroeconomic factors, changes of local demographic profile and negative factors such as potential rise crime rates, play undouble influence to property value. To understand the effects on the before- and after-of new infrastructure investment on property value, a further study is required. On the other hand, the analysis can be extended to test the effects of different walking distance from a property to the rail station and its affordability.

This study provides a benchmark for future hedonic pricing method in the area. As regression techniques apply in the hedonic method, multicollinearity issues sometimes cannot avoid from a large bundle of attributes. Other methods such as artificial neural network method could be tried to improve the accuracy in the future.

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