URBAN RAIL TRANSIT DEVELOPMENT IMPACTS IN DEVELOPING COUNTRIES: A CASE STUDY OF LAND PRICE IN BANGKOK, THAILAND

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ABSTRACT

The rail transit investment impacts on land development and increases in property value are well recognized in developed countries but less investigated in developing countries. This paper has the ultimate goal of examining the extent of the influence of rail transit investment in the context of land price in developing countries. Specifically, this study determines the spatial variation of the relationship between land price, and its attributes and accessibility to transit service. The Bangkok Metropolitan Area of Thailand is selected as a case study. A global regression framework is applied to determine the value of land based on its attributes. The global regression assumes that relationship is constant over space. However, the relationship often might vary across space because the attributes are not the same in different locations. Therefore, the variations of the influences on the land price are revealed by classifying data into different groups of land use such as residential and non-residential and incorporating spatial heterogeneity. The spatial statistical test is based on the geographically weighted regression model (GWR) that allows estimating a model at each observation point. The global regression model showed a significant correlation between land prices and its attributes and accessibility to transit service. However, the GWR model provided a better fit and revealed that rail transit has a positive impact on land price in some areas but negative in others. The increases in private land values generated by public investment such as rail transit development have been expected by developers. This benefit will be definitely reflected to the more than 10 transit lines that are planned for construction in the future. Understanding those impacts is necessary in order to allow the public agencies to tax the direct beneficiaries of their investments in the affected districts in advance so as to finance infrastructure projects.

Keywords: Urban rail transit, Land price, Global regression model, Local regression model, Bangkok

INTRODUCTION

Many cities of developing countries are now facing several urban problems such as serious traffic congestion, traffic safety, social inequity, and deteriorating environment. Solutions to these are the policies that have goals to improve accessibility, safety, and urban environment while develop and maintain a wealthy and healthy urban economy, offer a higher quality of life and transport opportunities for all community sectors. Therefore, a new paradigm shift in transport investments and urban development policies to make the cities more sustainable and economically viable has been implemented especially in rail-based transit system. Unfortunately, some of them cannot well get their expected targets because of poor planning on land use, poor connectivity with other existing transport modes and access difficulty. However, that rail transit system brings large effects on land development, real estate value and travel choice behavior in the adjacent area instead. The key to understand those effects is the concept of accessibility which is a general term used to characterize the ease of reaching opportunities or activities.

An important function of any rail transit system is to provide for people accessibility to residences; places for employment, recreation, shopping and so on; and for public goods and services, accessibility to points of production and distribution. Consequently, it can refer that the structure and capacity of rail transit networks affect the level of accessibility. Then, the adjacent areas of the rail transit corridors especially around the stations, which are the premium of transit accessibility, become the attractiveness areas for commercial developments and residential developments which lead to increased land values as competition for the sites rises.

Although, that urban rail transit brings large impact to the relative attractiveness of the locations near the railway networks is well recognized in many developed countries, however, in a city being young in urban railway experience is not gaining more attention. There are some attempts in Bangkok, property value and the number of building stock along BTS Skytrain corridor has remarkably increased in the research of Vichiensan et al (2011). It was concluded that the premium of transit accessibility adding to the property value is approximately $10 per sq.m for every meter closer to station of BTS Skytrain as mentioned in Chalermpong (2007). The benefit due to rail transit development also impact on the areas which is announced future extension. The objective of this study is to examine whether the urban rail transit investment has an impact on the land value. More specifically, the variations of the influences on the land value are allowed separate models to be estimated for two types of land uses: residential and non-residential land parcels and clearly presented by incorporating the spatial effect, namely, spatial heterogeneity, so as to reveal the relationship that might vary across space. This relationship will valuable to the public agencies to tax the direct beneficiaries of their investments in the affected districts.

The rest of this paper is organized as follows. Section 2, an overview of previous studies and spatial effect will be presented. Section 3 provides an introduction to a global regression and a spatial regression model of property value Discussions of Bangkok Metropolitan Region (BMR) situation, various data used for the analysis and descriptive statistics will be presented in section 4. Section 5, the models are estimated with the sample data. Finally provides the conclusion.

LITERATURE REVIEW

Rail Transit Influences on Property Values

Over the past decades, it has become increasingly clear that the presence of urban rail transit system can increase property values by improving accessibility. The most widely used method of studying capitalization of rail transit accessibility has spawned innumerable applications of the hedonic pricing model, first introduced by Griliches (1961) and Rosen (1974). Bajic (1983) performed one of the earliest of these studies using a hedonic price regression model in order to identify the effects of a subway line in Toronto on the values of housing units. Empirical results indicated that the direct saving in commuting costs have been capitalized into housing values. Nelson (1992) determined surrounding the effect on the value of single-family homes of heavy-rail transit stations in residential neighborhoods in Atlanta, Georgia. Based on the results, it claimed that transit stations have positive price effects on homes in lower income neighborhoods but have negative impacts in high income neighborhoods. Gatzlaff and Smith (1993) examined the impact of the development of the Miami Metrorail system on residential property values proximate to its station locations using hedonic regression method. In this case, the result showed that the residential values were, at most, only weakly impacted by the announcement of the new rail system. Forrest et al. (1996) examined the relationship between the availability of commuter rail services and the pattern of house prices in an urban area, and to assess whether modernization of facilities can modify prices using a hedonic longitudinal theory in Manchester, England. The findings indicated that no discernible effect in the pattern of housing prices was found when comparing before and after project. So et al. (1997) attempted to analyze the importance of transportation including heavy rail and bus in determining housing prices in Hong Kong. Bae et al. (2003) investigated the impact of the construction of a new subway line on the nearby residential property prices. A hedonic study indicated that the proximity from the subway station has a statistically significant effect on prices only prior to the line's opening. In Buffalo, New York study showed with hedonic regression that every foot closer to a light rail station increases average property values by $2.31 (using geographical straight-line distance) and $0.99 (using network distance) (Hess and Almeida, 2007). Similarity, a hedonic regression in Shanghai showed the premium land value of proximity to train station about 152 yuan/sq.m. for every 100 meter closer to a metro stations (Pan and Zhang, 2008). The summary of the impact of urban rail transit have increased a total number of 7.814 billion yuan on the surrounding residential values of Chengdu Metro Line 1 (Zhang et al. 2012).

A number of studies performed sought to distinguish between the accessibility benefits of rail transit and other transportation systems. Ryan (2005) analyzed with simple regression model

by comparing the importance of access to light rail transit and highway systems in estimating office and industrial property rents in San Diego area. The estimation showed that access to highway is significant effect to office rent while access to LRT is not.
Various rail transit modes are similarly important factors determining the degree of property value influence. In Santa Clara Country, California, Cervero and Duncan (2002) examined the degree to which proximity to two forms of rail transit between light rail and commuter rail confer benefits to residential properties in terms of sale values using hedonic price models. Some of the largest premiums were found for large apartments within a quarter-mile of light rail stations – on average 45 percent.

Spatial Non-Stationarity

As above, literatures found both positive and negative impacts of the urban rail transit and other transportation system. Often, the hedonic price model, applied the context of a simple regression, was used to examine the variations of the relationship between the property value and the proximity to the major transportation infrastructures especially rail stations. In general, the simple regression assumes that relationship is constant over space. However, the relationship often might vary across space because the attributes are not the same in different locations. Therefore, it is natural to suspect the spatial effects association between land or property values and its attributes in particular proximity factors. Recently, literatures in urban studies have shed light on to the spatial association between property values and nearby properties tend to be similarly valued whereas the same type of properties at distant locations may be valued quite differently. They also focus on the local variation of the impact by incorporating heterogeneity or the so-called non-stationarity. The statistical test for spatial heterogeneity is based on the geographically weighted regression model (GWR) (Fotheringham et al. 2002).
Some of the studies have structuralized the spatial heterogeneity with a simple regression for example Du and Mulley, 2006; Farooq et al., 2010; and Vichiensan and Miyamoto, 2010. The spatial heterogeneity has been employed to examine the impacts of transport accessibility and land value in Tyne and Wear Region, UK and found that non-stationarity existing in the relationship. Some areas have a positive impact on land value in some areas but negative in others (Du and Mulley, 2006). Similarity, a study in Toronto, Canada also employed the spatial heterogeneity and indicated that access to transport infrastructure are significant in explaining the variation in the office rent (Farooq et al., 2010).

Impact of Location and Neighborhood Characteristics

Not only station proximity has been considered to property or land value impacted, but also the characteristics of a property. What constitutes the characteristics of a property? Previous literatures point to location and neighborhood attributes (for example McDonald and McMillen, 1990; Cervero and Duncan, 2002; Kim and Zhang, 2005; Ryan, 2005; Chalermpong 2007; Chalermpong and Wattana, 2010; Diao and Ferreira, 2010; Farooq et al., 2010; Vichiensan and Miyamoto, 2010; and Vichiensan et al., 2011).

Location refers to the specific placement of a property which affects the prices. Specifically, the location affects the prices that reflect character of the area. The property is a part of a neighborhood and should be viewed in the community setting. Since the property is fixed in location, it differs in terms of its surroundings. Facilities of transport, education, health care, shopping and recreation are factors to be considered when investigating the property prices. Property in good locations and neighborhoods commands higher sale prices than those in bad locations and neighborhoods. As mentioned above, that is, spatial variation in property prices can be explained by differences in location and neighborhood attributes in space. McDonald and McMillen (1990) used distances to subcenters to predict residential land values in Chicago, also including distances and travel time to transportation infrastructure. In Manchester, UK, a distance to station and CBD, in particular, were included in the locational characteristics to assess the significance of the property and only the distance to station has increased the prices but not related to the distance to CBD (Forrest et al., 1996). Likewise, the analysis of property prices before and after the opening of Taipei subway system was examined based on location of property (e.g. CBD, suburban), position of property (e.g. close to station, school and parks), land use zoning (e.g. commercial and residential) and suggested that the price was increased after subway opened its service however the price changes vary significantly with differences in submarket: property location in relation to CBD, subway station and land use zoning (Lin and Hwang, 2004).

The population density, median income, flooding, level of security, incidence of crime, the noise level, number of markets and shopping centers, number of waste disposal centers, number of children's playground, number of recreation facilities, number of nursery and school, number of parking facilities, and number of private clinics in the neighborhood were also chosen to be a representative attributes of locations and neighborhoods effect on the property values with their methods (for example, Haider and Miller, 2000; and Aluko, 2011). Previous research has provided mixed evidence including large positive, small positive as well as negative effects.

MODEL SPECIFICATION

In this study, two types of model specification are presented. Global regression model is a reference model and Local Regression model, i.e., geographically weighted regression model is to shed light on the spatial effect vary across space.

Global Regression Model

Regression analysis is used to interpret the relationship between one (or more) dependent and a number of independent variables. The global regression equation of land value can be written as follow:

$$Y = \beta_0 + \beta_1 X_1 + ... + \beta_k X_k + \varepsilon \qquad (1)$$

Equation (1) can be written more compactly as:

$$\mathbf{Y} = \mathbf{X\beta} + \boldsymbol{\varepsilon} \tag{2}$$

where *Y* is the land value of observation, *X* is the attributes of the land value of observation, *ε* is the random error term of observation and β is the coefficient parameters of each attribute. Classical ordinary least squares (OLS) is obtained by assuming the errors to be normally distributed with an expected value of 0 and the solution for the coefficients is obtained as:

$$\boldsymbol{\beta} = (\mathbf{X'X})^{-1}\mathbf{X'Y} \tag{3}$$

Local Regression Model

Geographically weighted regression (GWR) is the term used to describe a family regression model in which the coefficients, *β*, are allowed to speculate on the relationship that might not be constant over space. (Fotheringham et al., 2002)
The regression model in Equation (2) may be rewritten for each local model at observation location *i* at the coordinates *u,v* as follows.

$$Y_i = \beta_0(u_i, v_i) + \beta_1(u_i, v_i)X_1 + \ldots + \beta_k(u_i, v_i)X_k + \varepsilon_i \tag{4}$$

Equation (4) can be written more compactly as:

$$\mathbf{Y} = \mathbf{X\beta(i)} + \boldsymbol{\varepsilon} \tag{5}$$

where the sub-index *i* indicates an observation point where the model is estimated. The coefficients are determined by examining the set of points within a well-defined neighborhood of each of the sample points. This neighborhood is essentially circle, radius *r*, around each data point. However, if *r* is treated as a fix value in which all points are regarded as of equal importance, it could be include every point (for *r* large) or alternatively no other points (for *r* small). Instead of using a fixed value for *r* it is replaced by a distance-decay function (De Smith et al. 2007).
A simple function may be defined such as $f(d)=\exp(-d^2/h)$, where *d* is the distance between the focus point and other points, and *h* is a parameter, so-called bandwidth.
Using the function and bandwidth, *h*, a diagonal weighted matrix, W(i) where is the geographically weighting of each of the *n* observed data for point *i*, may be defined for every sample point, *i*, with off-diagonal elements being 0. The parameters β(i) for this point can be determined following the framework of global regression, the local parameter estimates can be obtained:

$$\boldsymbol{\beta}(\mathbf{i}) = (\mathbf{X'W(i)X})^{-1}\mathbf{X'W(i)Y} \tag{6}$$

DATA

Study Area

Bangkok Metropolitan Region, a capital city of Thailand, is selected as a case study for the empirical analysis. The Bangkok Metropolitan Region (BMR), also known as Greater Bangkok is the urban conglomeration of Bangkok, Thailand, consists of a large core so-called Bangkok Metropolitan Area (BMA) and the five vicinities of Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan, and Samut Sakhon. It covers an area of 7,761.50 km^2 and has an estimated population of 15.6 million in 2012 with a population density of 1,301.42 per km^2 (National Statistical Office, NSO). The BMR has two major central business districts (Silom and Sukhumvit) and several commercial districts (e.g. Siam Square, Rama 4, and Petchaburi) situated in different parts of the city. Recently, detached and attached homes are common in common in outlying low-density area such as the suburban of Bangkok and the areas of the adjacent provinces, however, they have become increasingly rare in central Bangkok, where high-rise building for residence such as condominiums and apartments have become the norm.
Recently, the urban rail transit has been introduced to alleviate the traffic issues. In December 1999, the first 23.5-kilometer elevated rail transit, the so-called BTS Skytrain, has started its service with two initial green lines: the 22-kilometer of Sukhumvit line and the 8.5-kilometer of Silom line. Five years later, the second 20-kilometer Bangkok Mass Rapid Transit (Chaloem Ratchamongkhon line or MRT Blue line) was launched at underground level in July 2004. The third 28.5-kilometer Suvarnabhumi Airport Rail Link, also known as Airport Link has opened in August 2010. Among of them are five transfer stations that is no track connection, namely Asok, Mo Chit, Sala Daeng, Phaya Thai, and Phetchaburi. Nowsadays travel by rail transit in Bangkok has increasingly obtained interest due to its safe, punctual, as well as convenient service. Although there are only three lines are currently in operation, the new urban rail transit lines consist of a 15-kilometer SRT Light Red line, a 23-kilometer MRT Purple line and a 27-kilometer extension of MRT Blue line are now constructed in January 2009, November 2009 and June 2011, respectively. Moreover, a 12.8-kilometer of the extension of BTS Skytrain, from Bearing Station to Sumut Prakan Station, will be built in 2012. The existing and under construction urban rail transit network are shown in Figure 1.

Data and Variables

Since this paper is an empirical study, it is necessary to collect several data from various sources. Among various types of required data, land price data used to carry out this paper was obtained from the assessed land value reports, which were published by The Treasury Department, Thailand. This report generally uses to determine the property taxes for local government. The period time of this land value report had employed to capture taxes during the year 2008 to 2011 (assume the same land value for 4 years); however, it was evaluated before published around 2 years, i.e., this assessed value had started evaluated since 2006 and published in the year 2008. In addition, the assessed land value is an unrealistic value.

In the other word, it often too low, but sometimes high; however, it often bears relationship to the real value of property. Although the assessed land value is not a true market value, it is used in this study because the market transaction price data is not consistent and reliable in Thailand. Geographic Information System (GIS) is used to plot the location of each land parcel. For the purposes of this study, data observations for residential and non-residential land parcels were selected. The total sample included 1,368 effective samples: 925 residential land parcels which mainly consist of single-detached housing and 443 non-residential land parcels which mainly consist of office building and retail shops.

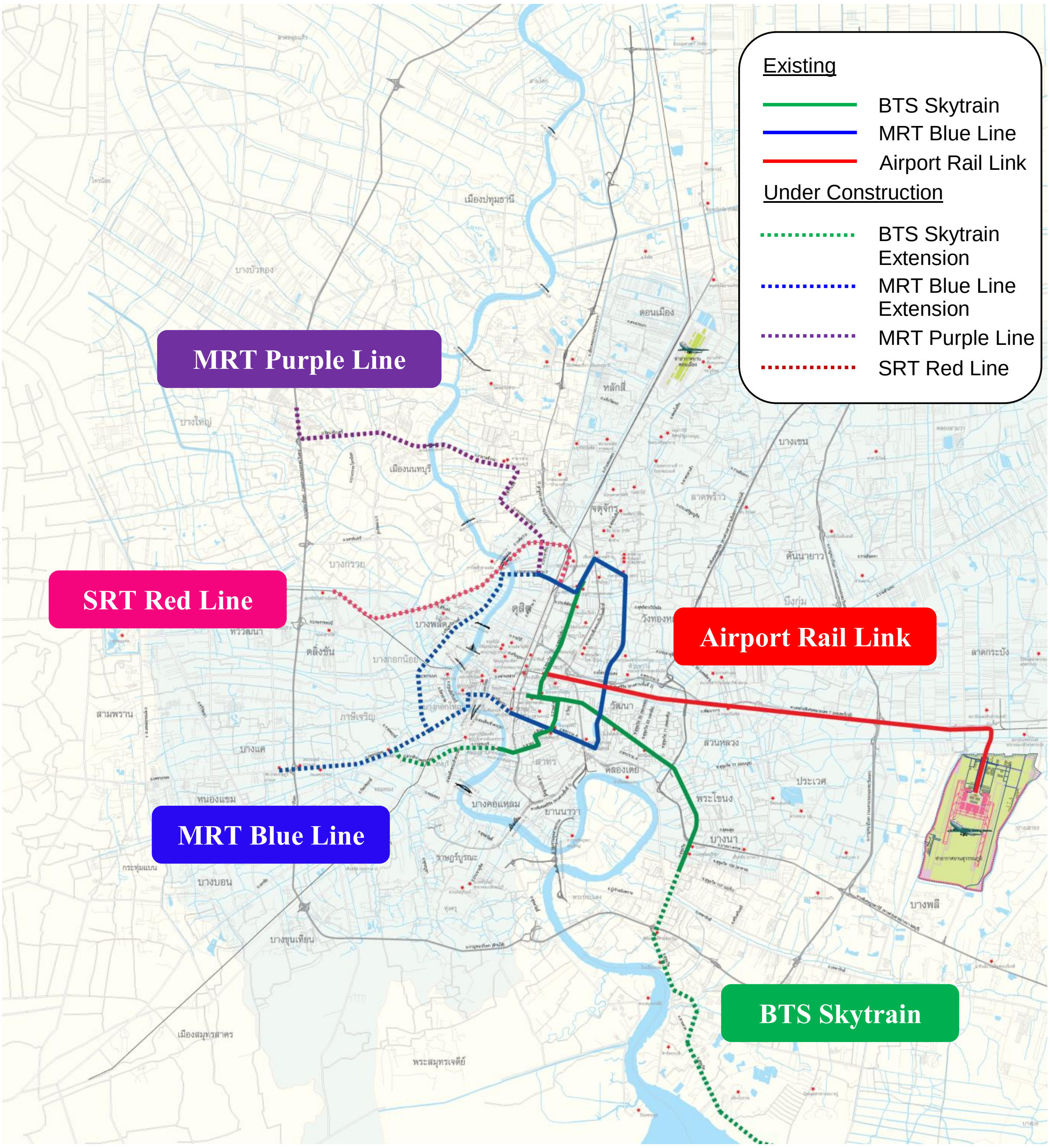

Figure 1 - Map of Bangkok Metropolitan Region (BMR), existing and extension urban rail transit network

Table 1 provides variables description and data sources that will be used to estimate. Based on past studied, three types of information were used as independent variables: location characteristics, neighborhood economic and demographic attributes and land attributes.

Table 1 – Variables description and data sources

Variables	Description	Data Source
Dependent variable		
LPRICE	Land price during 2008-2011 (1,000 baht/sq.m)	Treasury Department
Independent variable		
Location Factors (Straight Line Distance)		
DIST_BSSTA	Distance to BTS Skytrain station (km)	Calculated using GIS
DIST_MBSTA	Distance to MRT Blue Line station (km)	Calculated using GIS
DIST_MR	Distance to main road (km)	Calculated using GIS
DIST_EXP	Distance to expressway access (km)	Calculated using GIS
DIST_CBD	Distance to CBD: Siam Square (also represented as city center area) (km)	Calculated using GIS
DIST_SHP	Distance to shopping center (km)	Calculated using GIS
Neighborhood Economic and Demographic Attributes		
POP_DEN	Population density at the year 2008 (persons/sq.km)	Transportation model of
MED_INC	Median income at the year 2008 (baht)	Bangkok and National
EMP_DEN	Employment density at the year 2008 (positions/sq.km)	statistical office (NSO)
Land Attributes and Regulation		
LSIZE	Land size during 2008-2011 (100 sq.m)	Treasury Department
RL	Residential land at the year 2011	Department of Lands
NRL	Non-Residential land at the year 2011	Department of Lands

Let notice the table, The location factors in this study, consist of five variables including distance to urban rail transit station, main road, expressway ramp (as in entrance ramp), central business district (CBD), and shopping center, are indicated accessibility indexes both transportation and centers of activities. The distance to urban rail transit station, main road, expressway entrance, and shopping center are measured by the straight line distance and the nearest distance is selected using Geographic Information System (GIS) tools.

In addition, for the proximity to urban rail transit station, capitalization effects were thought to vary by transit corridor in order to measure differences in land price impacts for the existing urban rail transit network. In accordance with the period time of land price data, the existing lines are defined as: BTS Skytrain and MRT Blue Line. In addition, the shopping center in this study means a building forming a complex of shops, recreations, amusements, etc. As a difficulty to identify the boundary of the CBD, hence, Siam Square is assigned to be the CBD of Bangkok Metropolis because there are the centers of many kinds of activities, e.g., shopping center and employment area. In addition, the proxy to central business district

(CBD) is represented the inner city area of Bangkok Metropolitan Region. For the location factors are set to determine the extent of location factors especially distance to urban rail transit station. The expected result should be the shorter distance, the more valuable they are.

The neighborhood economic and demographic attributes, consist of population density, median income, and employment density, are obtained from the transportation model of Bangkok Metropolitan Region and the National Statistical Office (NSO). These variables are chosen to determine the effect of neighborhood attributes.

Finally, land attributes and regulation are obtained from various sources. Land size is obtained from the Treasury Department. Land regulation is divided into three categories: residential land parcels and non-residential land parcels.

Descriptive Statistics

Table 2 presents summary statistics for each dependent and independent variable used in the land value models, broken down by the land use types. Not surprising, on average, the most expensive properties were found for non-residential type, around 102,000 baht/sq.m. For the station proximities, non-residential type tended to be closer to the BTS Skytrain and MRT Blue Line stations than residential type. Comparing between distance to main road and access point to expressway, residential land parcels were closer to main road than access point to expressway, however, non-residential land parcels tended to be near either main road or expressway. Obviously, non-residential land parcels were found nearer to the CBD and shopping center than residential land parcels.

Table 2 – Descriptive statistics

Variables	Mean	
	Residential	Non-Residential
LPRICE (1,000 baht/sq.m)	33.38	102.37
DIST_BSSTA (BTS Skytrain) (km)	8.01	4.11
DIST_MBSTA (MRT Blue Line) (km)	7.78	4.61
DIST_MR (km)	0.76	0.31
DIST_EXP (km)	4.14	2.77
DIST_CBD (km)	12.25	7.36
DIST_SHP (km)	3.62	2.85
POP_DEN (persons/sq.km)	10,629	19,600
MED_INC (baht)	29,439	33,034
EMP_DEN (positions/sq.km)	7,087	20,469
LSIZE (100 sq.m)	13.06	23.63

For the neighborhood economic and demographic attributes and land attributes, residential land parcels being located farther away from the CBD were generally in lower population and employment density than non-residential type being located near or in the CBD. Furthermore, non-residential parcels were generally in the higher employment density and higher median income areas than residential parcels. Finally, the land size of residential type tended to smaller than non-residential type.

LAND VALUE MODELING

This section presents the results for the two types of land uses; residential land value model and non-residential land value model, along with the spatial variations of the parameters in maps that measured land value premiums or discounts.

Residential Land Value Model

Table 3 presents the residential land value model which were calibrated by the ordinary least squares (OLS) and geographically weight regression (GWR) method. The goodness-of-fit is evaluated by the coefficient of determination (R2) and residual sum of squares (RSS) which are measured how well the models are.

As mentioned, the OLS model is estimated where the resulting coefficients are global meaning that the coefficients are constant over the study area while the GWR model gives local parameter estimates for each observation points, i.e., a total of 925 sets of estimates are obtained. However, in Table 3 shows only minimum, maximum, and average values. The estimation framework is the same trend as global regression (OLS model).

Table 3 – Residential land parcels: Global regression (OLS) and local regression (GWR)

Variables	OLS			GWR			
	Coef.	t-stat	p-value	Min	Max	Mean	p-value
Independent variables							
Location factors (Straight line distance)							
DIST_BSSTA	-8.245	-3.812	0.000	-1,216.992	1,491.796	-2.171	0.000
DIST_MBSTA	-3.180	-1.696	0.090	-1,788.390	785.778	-6.858	0.000
DIST_MR	-6.521	-6.995	0.000	-36.511	12.399	-3.942	0.000
DIST_SHP	2.800	1.870	0.062	-86.449	76.667	-1.926	0.000
DIST_EXP	2.838	2.026	0.043	-171.736	461.602	-0.990	0.000
DIST_CBD	-17.224	-4.877	0.000	-2,785.301	2,867.719	-16.212	0.000
Neighborhood attributes							
POP_DENS	-7.293	-4.468	0.000	-88.522	58.289	-1.631	0.000
EMP_DENS	3.779	3.308	0.000	-56.126	44.711	-0.905	0.000
R^2	0.49			0.73			
RSS	696,642.5			255,317.8			
Number of observation	925			925			

Let notice the table, the GWR model has much better predictive powers than the OLS model, explaining around 70 percent of the variation in assessed prices among 925 parcels, which mainly consisted of detached housing. With the residual sum of squares for both the GWR and the OLS being compared, the lower GWR residuals suggest that there is a significant improvement in the model fit when the GWR is adopted. Based on a Monte Carlo test procedure, some independent variables were insignificant at the 5% level in the global parameter estimated but the GWR can examine the significance of the spatial variability of parameters, suggesting that these factors, e.g., distance to station and distance to shopping center, were a factor in some areas but not in other areas. Finally, there is no relationship between the independent variables mentioned.

Global Regression Model: Ordinary Least Squares (OLS) for Residential Land Value

For the OLS model, some independent variables had expected signs. There were positive effects enjoyed by residential parcels near urban rail transit (BTS Skytrain and MRT Blue Line) indicated by the negative sign in the proximity to station variables. This means the shorter distance from each parcel to the station, the more valuable it is. The largest benefits accrued to parcels near the BTS Skytrain network. From the model, the premium value is approximately 8,000 baht/sq.m every kilometer closer to the station. The OLS model result also indicated a benefit from being close to main road and CBD, reflected by prices increasing around 6,500 baht/sq.m per kilometer and 17,000 baht/sq.m per kilometer closer. In contrast, the OLS model suggests a dis-benefit created from being near shopping center and access point to an expressway, indicated by the positive sign on the distance to the shopping center and expressway variables. The other variables had signs that matched a priori expectations. As following, population density decreased and employment density increased, the land value was uplifted.

Local Regression Model: Geographically Weight Regression (GWR) for Residential Land Value

As identified above, the GWR model can examine the significance of the spatial variability of parameters. Based on the hypothesis that spatial effect, spatial heterogeneity, is present in the data. The Figure 2 to Figure 4 show the coefficient at each observation point in this study that obtained from the GWR model. Obviously, the coefficients vary substantially. In addition, these figures present only the variables related to the existing urban rail transit network and another one presents the independent variable that is not the same sign compared between the OLS and GWR model (e.g. distance to expressway ramp).

Firstly, in Figure 2 presents the variation of the station proximity coefficients, a distance to the nearest station of BTS Skytrain relating to land value. In the areas that are served by BTS Skytrain such as shades of red, land price is strongly influenced by the proximity to BTS Skytrian station compared with the area not being served by BTS Skytrain, e.g., in shades of green. Likewise, in Figure 3 found that the price of properties is sensitive to station proximity in shades of red, which is an adjacent area along the MRT Blue Line. On the other hand, it found the positive coefficient in shades of green meaning that although the distance to be large, the price is not decreasing because they are located farther away from the stations. This implies that land price in the station catchment area is substantially influenced by the station proximity.

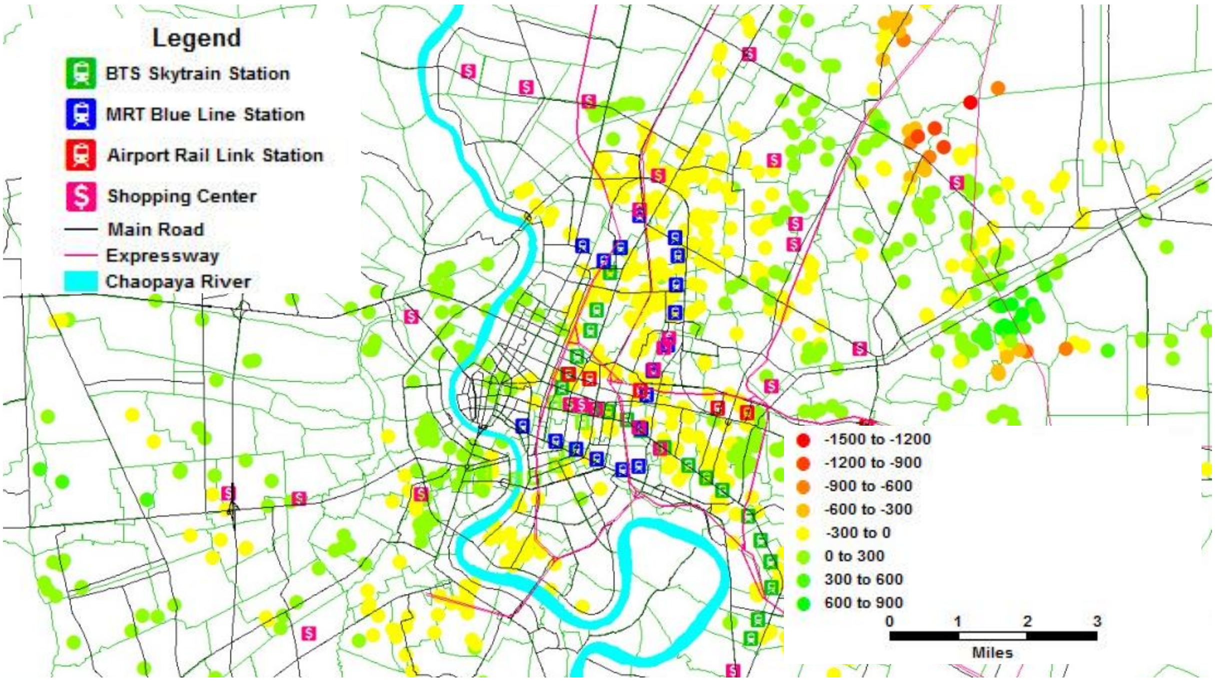

Figure 2 - The coefficients of distance to BTS Skytrain stations for residential land value

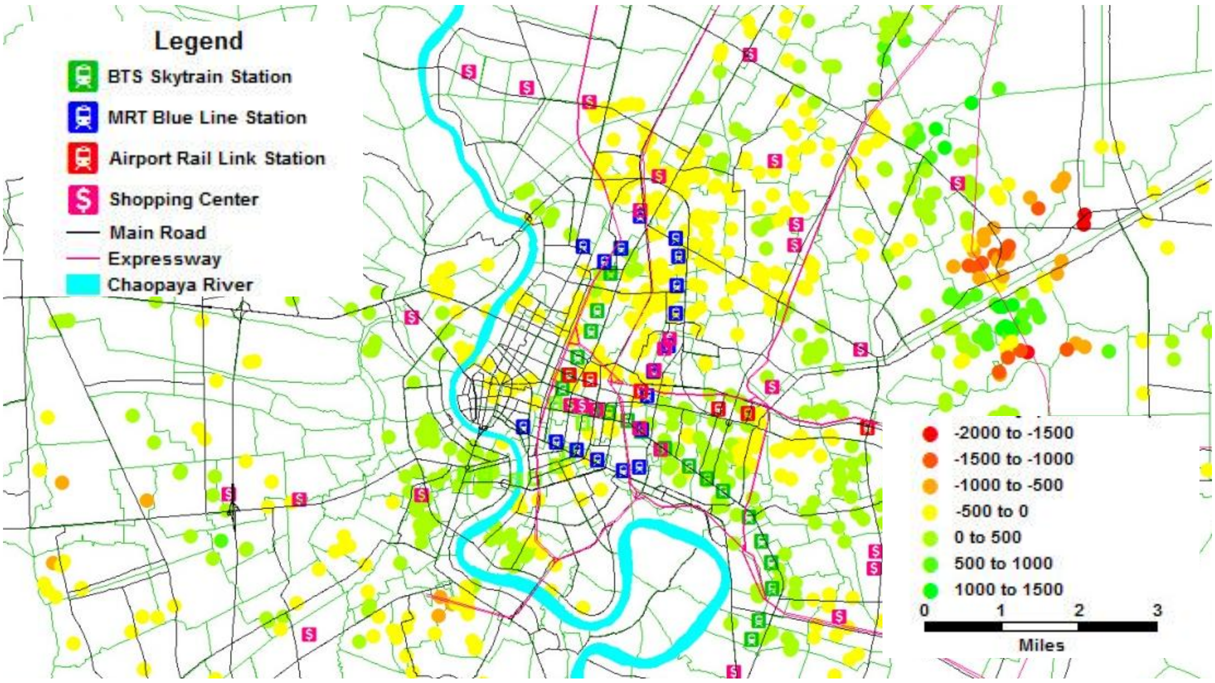

Figure 3 - The coefficients of distance to MRT Blue Line stations for residential land value

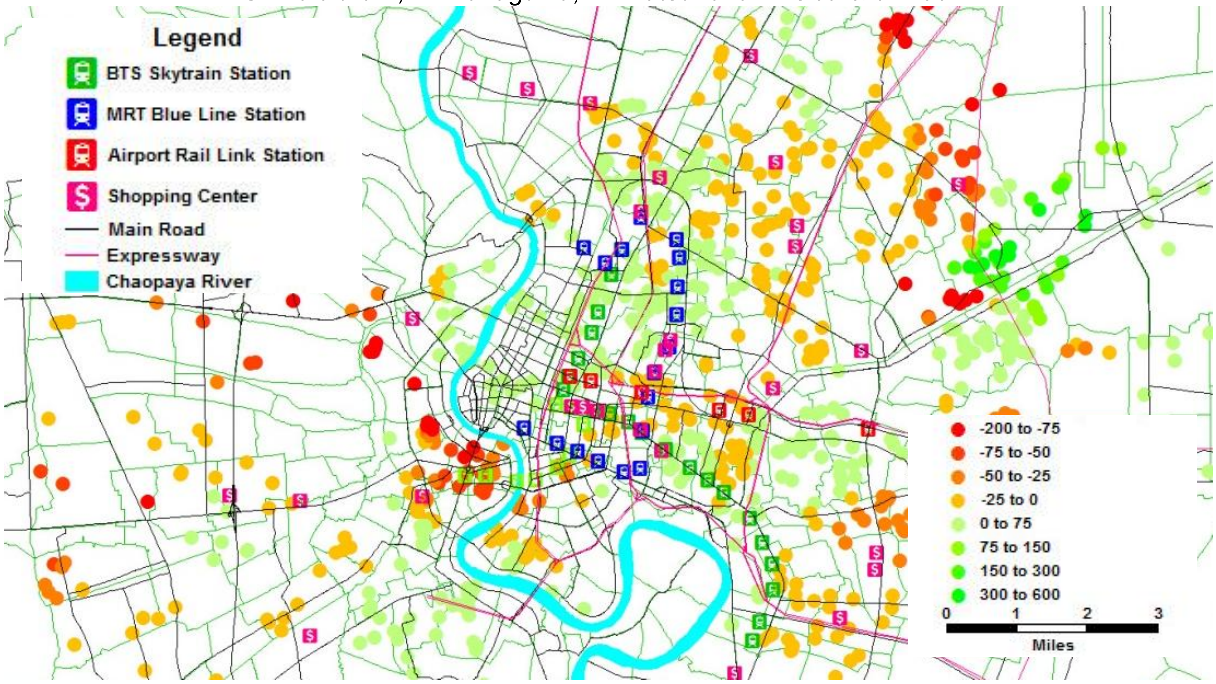

Figure 4 - The coefficients of distance to expressway ramp for residential land value

Next, in Figure 4 the local coefficients of access point to an expressway ramp variable estimated were shown as different color points. It found the coefficients are negative in shades of red where most of them are located in urban fringe and suburban and also known as a high-density residential area. Due to the fact that most people in Bangkok get around by their private car, hence, using the expressway is the best way to reduce the travel time. In contrast, the coefficients were found a dis-benefit from being near the urban rail transit corridors and the CBD, indicated by positive sign in shades of green. These results could be indicating that if the rail transit network is served, the mode choice will be shifted to public transport.

Non-Residential Land Value Model

Findings from the non-residential land value modeling, which were calibrated by the ordinary least squares (OLS) and geographically weight regression (GWR) method, are presented in Table 4. The GWR model gives local parameter estimates for each observation points, i.e., a total of 443 sets of estimates are obtained. However, in Table 4 shows only minimum, maximum, and average values.

In this analysis, the GWR model benefits from a higher coefficient of determination, explaining around 75 percent of the variation in assessed prices among 443 parcels which mainly consisted of office building and retail shops, and a lower sum residual of squares. Based on a Monte Carlo test procedure, the results of these tests show that the population density variable significantly varies over space although this variable was insignificant in the OLS model. Finally, there is no relationship between the independent variables mentioned.

Table 4 – Non-Residential land parcels: Global regression (OLS) and local regression (GWR)

Variables	OLS			GWR			
	Coef.	t-stat	p-value	Min	Max	Mean	p-value
Independent variables							
Location factors (Straight line distance)							
DIST_BSSTA	-23.346	-5.248	0.000	-419.970	1,796.157	-9.694	0.000
DIST_MBSTA	15.607	2.440	0.015	-283.988	602.075	-16.438	0.000
DIST_MR	-17.687	-6.963	0.000	-48.750	2.429	-14.478	0.000
DIST_SHP	24.482	5.382	0.000	-4,952.877	3,682.062	-4.583	0.000
DIST_EXP	15.008	3.450	0.000	-545.83	76.116	9.288	0.000
DIST_CBD	-64.291	-6.876	0.000	-4,613.869	4,231.560	-33.347	0.000
Neighborhood attributes							
POP_DENS	-11.735	-1.997	0.046	-248.713	36.221	-4.017	0.000
EMP_DENS	15.872	4.097	0.000	-89.787	85.377	-0.547	0.000
R^2	0.51			0.75			
RSS	2,027,918			842,223.6			
Number of observation	443			443			

Global Regression Model: Ordinary Least Squares (OLS) for Non-Residential Land Value

Table 4 reveals very similar patterns were found for non-residential land parcels as with residential land parcels, with one notable exception. Owning non-residential parcels near BTS Skytrain corridor confer benefits on average, a value-added of some 23,000 baht/sq.m per kilometer closer to the stations. In contrast, parcels being near MRT Blue Line corridor (which is a semi commercial-residential area) sold at a lower price than otherwise comparable parcels, suggesting the existence of a dis-amenity effect. Besides, there was a stronger increase in non-residential land prices with distance to main road than there was a decline with distance from the shopping center, suggesting that, parcels generally went for more when they were a reasonable buffer distance near the main roads. The model results also suggest, being near the CBD created benefit, reflected by the negative sign on the distance to CBD variable. This means the shorter distance from each parcel to the CBD, the more valuable it is. Other control variables from Table 4 matched expectations and the explanations is the same as before.

Local Regression Model: Geographically Weight Regression (GWR) for Non-Residential Land Value

The Figure 5 to Figure 7 show the coefficient at each observation point in this study that obtained from the GWR model. In addition, these figures present only the variables related to the existing urban rail transit network and another one presents the independent variable that is not the same sign compared between the OLS and GWR model (e.g. distance to shopping center).

Firstly, in Figure 5 presents the variation of the station proximity coefficients, a distance to the nearest station of BTS Skytrain relating to land price. In the areas that are served by BTS Skytrain such as the yellow, land price is strongly influenced by the proximity to BTS Skytrain station compared with the area not being served by BTS Skytrain, e.g., in the green. Likewise, in Figure 6 found that the price of properties is sensitive to station proximity in the orange, which is an adjacent area along the MRT Blue Line corridor. On the other hand, it found the positive coefficient in green color meaning that although the distance to be large, the price is not decreasing because they are located farther away from the stations. This implies that land price in the station catchment area is substantially influenced by the station proximity.

Next, in Figure 7 the local coefficients of shopping center variable estimated were shown as different color points. The shopping center locations were marked in the pinks. By visual inspection, areas around or being near the shopping locations contain parameters which had been colored in shades of red but farther away were colored in shades of green. Considering this variation, everything else being equal, the price is less sensitive to shopping center proximity in shades of red than in shades of green. In the other words, it is expected that being near shopping center locations will be more expensive than in shades of green. This is clearly shown the spatial variation for the shopping variable over different areas.

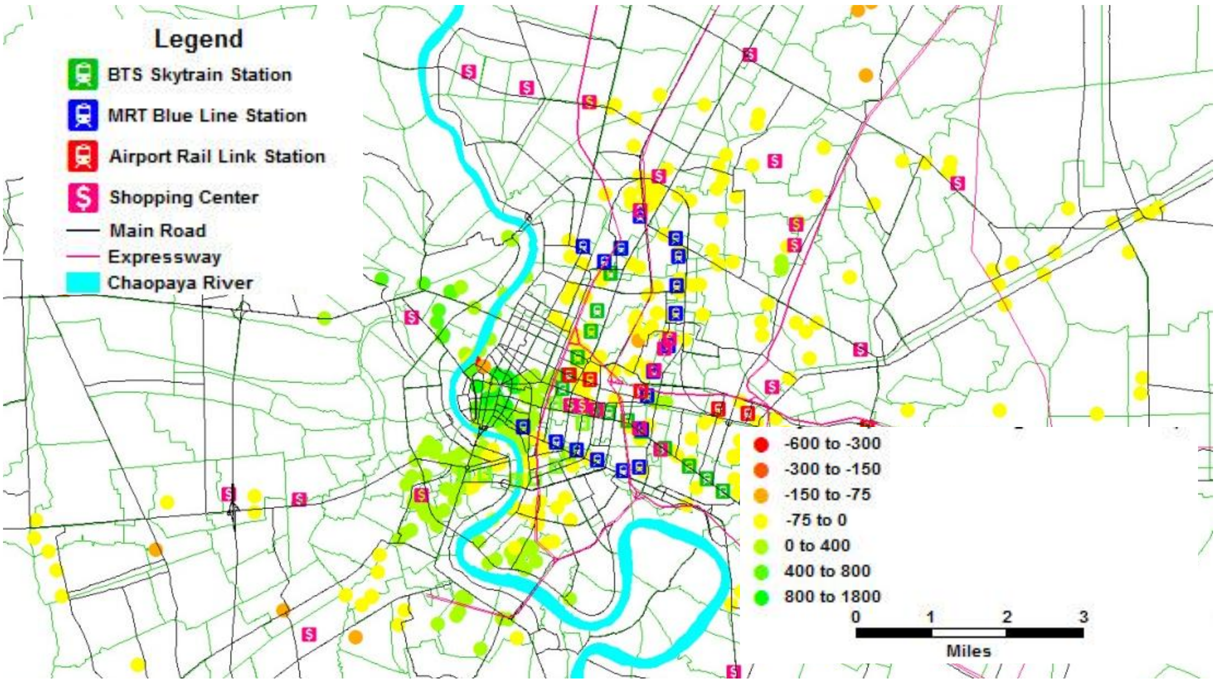

Figure 5 - The coefficients of distance to BTS Skytrain stations for non-residential land value

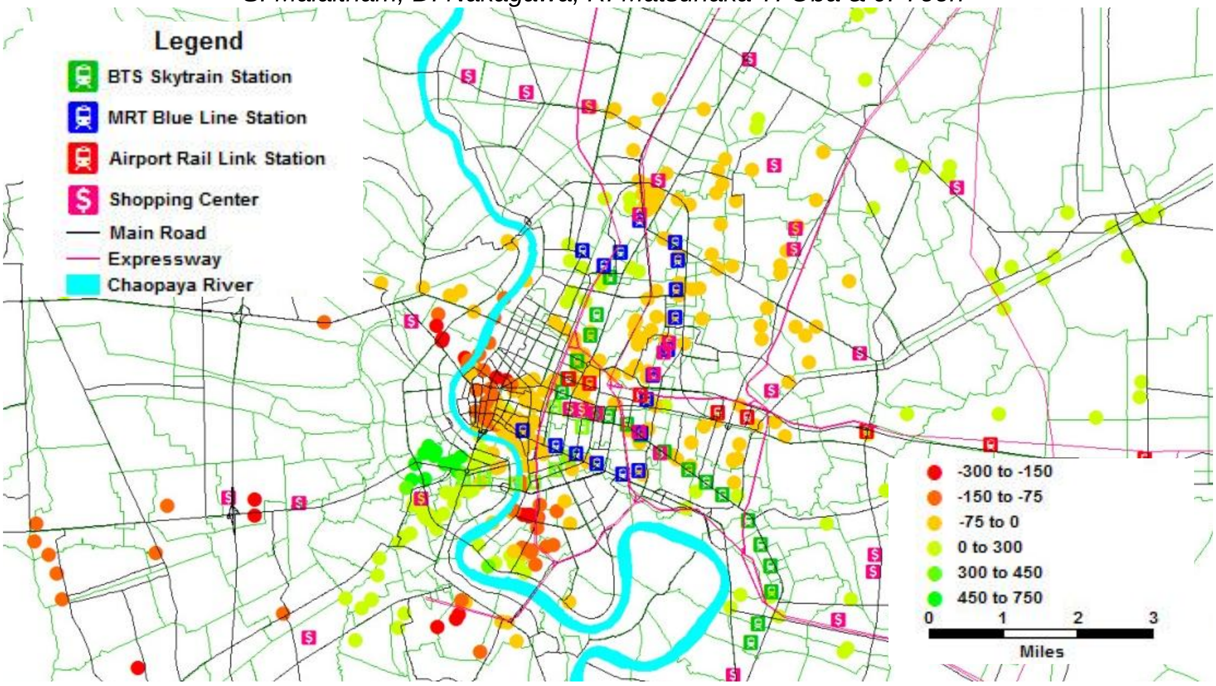

Figure 6 - The coefficients of distance to MRT Blue Line for non-residential land value

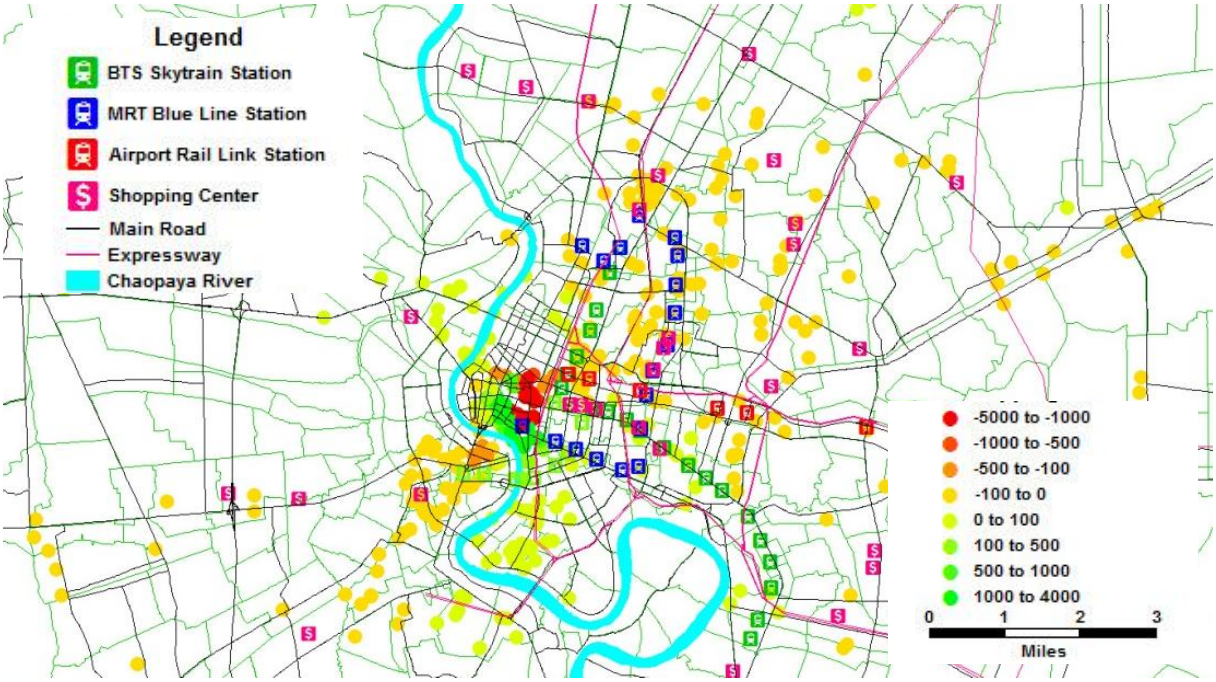

Figure 7 - The coefficients of distance to shopping center for non-residential land value

Station Proximity Premium Value

The findings on capitalization effects of parcels being near the urban rail transit station presents in this section. From the Table 3 and Table 4 using the coefficients of GWR models, the estimated premium of BTS Skytrain network for residential and non-residential land parcels are discount approximately 2,100 baht/sq.m and 9,700 baht/sq.m for every additional kilometer away from the station. And the estimated premium of MRT Blue Line network for residential and non-residential land parcels are discount approximately 7,000 baht/sq.m and 16,500 baht/sq.m for every additional kilometer away from the station. The premiums were estimated into the percentage price premium by measuring the percentage change in mean price (in Table 2) given a 1 kilometer change in each urban rail proximity variable, holding all other factors constant.

Figure 8 shows a summary of urban rail transit accessibility premiums in the present study when everything else being constant. As shown, the amenity effect of being near the MRT Blue Line station is larger than the amenity effect of being close to the BTS Skytrain station, reflected by the percentage change for every kilometer closer. Although the BTS Skytrain might not be implemented, the land values are more expensive than other areas because the BTS Skytrain is served mostly commercial and financial districts along Siam, Sukhumvit, Silom, Sathorn and Phaholyothin. Therefore, the land values being near the BTS Skytrain are less sensitive to station proximity than being near the MRT Blue Line.

With a focus on BTS Skytrain network, non-residential land parcels accrued appreciable benefits more than residential land parcels for the same distance to BTS Skytrain station. In the case of non-residential (e.g. commercial and office property), the land value premium produced by urban rail transit is higher near the city center than other areas (Kim and Zhang, 2005). In contrast, it is just the reverse for residential parcels, indicated by a higher land value premium from MRT Blue Line corridor, which runs through a semi commercial-residential area, e.g. Lat Phrao, Huai Khwang, Din Daeng, etc.

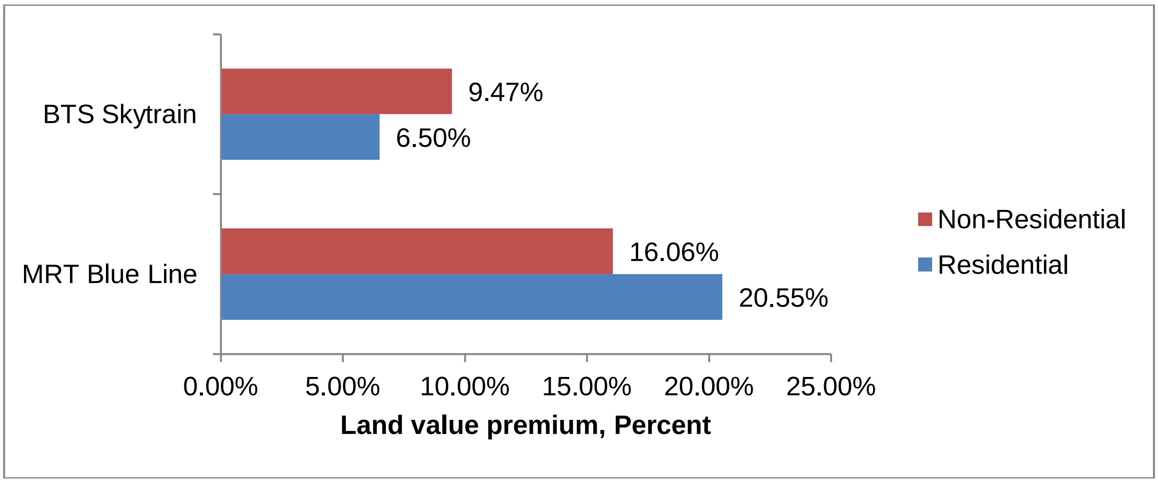

Figure 8 – Land value premiums by urban rail transit

CONCLUSION

This study is to investigate how the urban rail transit investment influences land values. The results is estimated and obtained using the context of regression framework. It is, furthermore, accommodating the spatial effect, i.e., heterogeneity which is estimated based on the geographically weighted regression model (GWR). The findings show the capitalization effects of parcels being near the urban rail transit station, though relationships vary considerably by land use type and corridor. Based on the GWR results, the estimated premium of BTS Skytrain network for residential and non-residential land parcels are discount approximately 2,100 baht/sq.m and 9,700 baht/sq.m for every additional kilometer away from the station. And the estimated premium of MRT Blue Line network for residential and non-residential land parcels are decline approximately 7,000 baht/sq.m and 16,500 baht/sq.m as distance to station increased. On the other hand, the land values being near the BTS Skytrain are less sensitive to station proximity than being near the MRT Blue Line. Obviously, urban rail transit service confers appreciable land price benefits to residential and non-residential parcels, though relationship varies by the corridor. Non-residential land parcels accrued appreciable benefits more than residential land parcels for the same distance to BTS Skytrain station. However, it is just the reverse for residential parcels along the MRT Blue Line corridor. The biggest value premiums were appeared for residential parcels, remarkably along the MRT Blue Line corridor. These results can form the basis formulation of value capture policies to tax the direct beneficiaries in the affected districts in advance so as to finance the urban rail transit infrastructure projects, in particular the more than 10 transit lines that are planned for construction in the future.

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