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The Impacts of Mass Transit Improvements on Residential Land Development Values: Evidence from the Bangkok Metropolitan Region

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ABSTRACT *This study examines the impacts of the new mass transit systems on the land values of residential development in the Bangkok Metropolitan Region, Thailand, using geographic information systems and spatial econometrics. The study finds that the proximity to mass transit stations spatially correlates with an increase in the prices of residential land. The benefits of the new mass transit stations, however, may not be equally distributed to the residents of Bangkok due to the lack of value-capture mechanisms such as a capital gains tax or a property tax. Policy implications regarding property taxation are also discussed.*

本文用地理信息系统和空间计量经济学，研究泰国曼谷市区新建大型交通系统对住宅开发中土地价值的影响。研究发现离大型交通站点越近，住宅用地的价格越高。但是，由于没有资本利得税或房产税等价值捕获机制，曼谷的居民可能并不能平等享受新建大型交通站点的益处。本文还讨论了房产征税的政策意义。

KEY WORDS: Spatial analysis, land values, mass transit, GIS, Bangkok

Introduction

Urban rent theory implies that the value of land is essentially influenced by the trade-off between accessibility and transport costs (Alonso, 1964; Muth, 1969; Evans, 1973). The price of land in urban rent theory, however, is treated as the price of pure land at a specific location, which is contrary to some recent suggestions that land is a composite good, and its value should be based on location-specific characteristics including neighbourhood and local public amenities (Cheshire & Sheppard, 1995). Infrastructure improvement thus plays an important role in the rise of land values. In particular, accessibility improvement in the

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form of public transportation or road improvement is found to cause the value of land to rise (Medda & Modelewska, 2010). Nonetheless, in many urban areas of developing countries in which the cities are often characterised as automobile oriented, the improvement in public transit can cause significant changes in land values that are unevenly distributed among landowners and other stakeholders (Smolka, 2013). For these developing countries, value-capturing mechanisms such as land value tax do not exist, further widening the disparity between the value of the land adjacent to infrastructure improvements and the land located farther away. Without knowing the impact of public infrastructure improvement on the value of land, the value-capturing mechanism cannot be implemented efficiently.

Within the past few decades, Bangkok has faced rapid growth in urban development due to the improvement in road and highway systems as well as the introduction of new public transportation. Many new residential developments in Bangkok have grown rapidly. Like many developing countries, Thailand lacks effective land value-capturing policies (Ratanawaraha, 2010). As a result, the disparity between the land close to new public transit and the land farther away has not been considered. Nevertheless, there have been few detailed studies of residential land in Bangkok—even fewer with spatial effects taken into consideration—and little is known about the impact of infrastructure improvement on land values.

This study examines the impacts of mass transit on land values in Bangkok. It consists of two major parts. The first part analyses the impact of proximity to mass transit—as well as to other public amenities including hospitals, schools and parks—on residential land values, explicitly taking into consideration the spatial effects of the locations of mass transit stations in spatial hedonic models. The analysis of current housing and real estate developments in the Bangkok Metropolitan Region (BMR) shows the evidence of changes in residential land values and patterns of urban structure with the impacts of existing and proposed rapid transit systems. It is one of the first attempts to examine the spatial relations of public transit and residential development in the entire BMR using spatial analysis methods. The second part demonstrates how the estimated parameters from the first part can be used in policy formation of land value taxation in Thailand. The study concludes with a discussion regarding policy implications and further studies.

Study Area: The Bangkok Metropolitan Region (BMR)

Within the past two centuries, the urban area of Bangkok has been growing from a settlement on the bank of the Chao Phraya River to one of the major metropolitan areas in Asia. The BMR covers an area of 7761.66 square kilometres and includes six provinces, namely, Bangkok, Nonthaburi, Nakhon Pathom, Pathum Thani, Samut Prakan and Samut Sakhon (see Figure 1). As shown in Figure 2, since the 1960s, its urban structure has been rapidly expanding due to the development strategies in Thailand's national development plans.

To improve the quality of life and stimulate economic growth, a large amount of government expenditure has been invested in public infrastructure such as road networks, mass transit systems and utilities. However, urbanised areas have grown without effective control from the government, while housing development in the city has been led mainly by real estate developers. Consequently, the urban areas of the BMR have expanded along major road networks, resulting in strip developments, especially on the outskirts of the region. BMR's freeways have been major pathways for people to commute to the city centre. As a result, traffic congestion has become one of the most serious problems of the

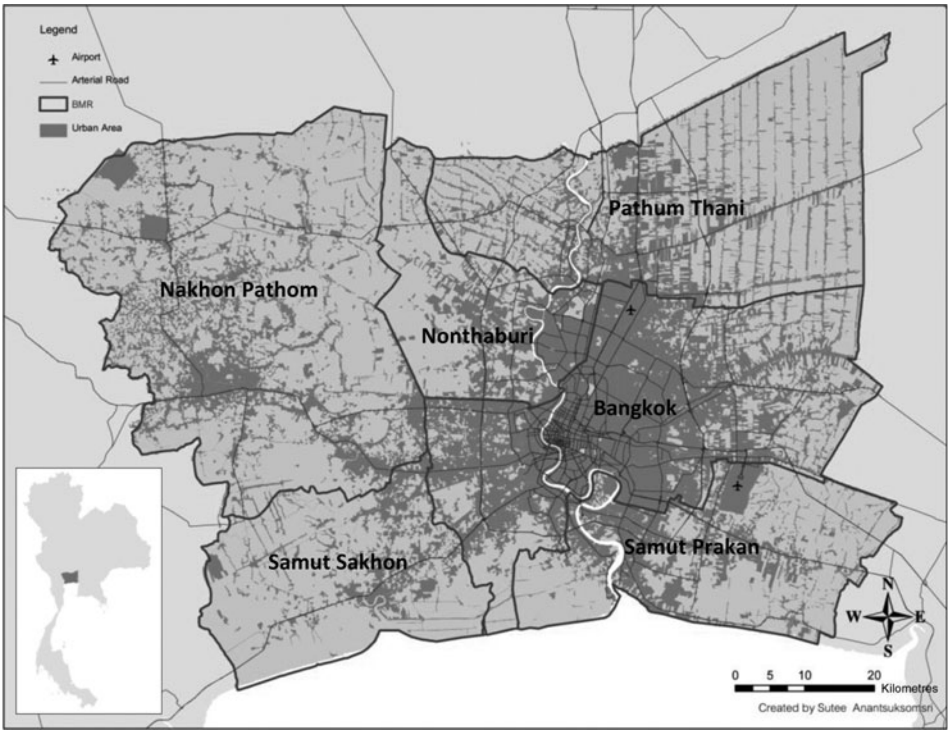

Figure 1. The Bangkok Metropolitan Region (BMR) in 2010

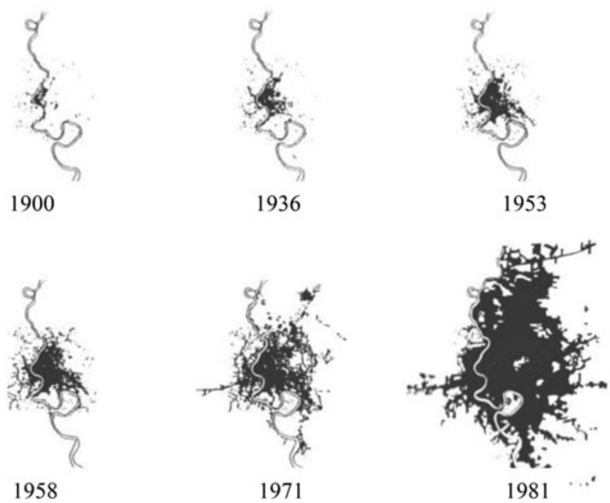

Figure 2. The urban area of the BMR from 1900 to 1981. Source: Adapted from Sternstein (1982).

city since the transportation policies in the past concentrated mostly on construction of new roads, rather than on traffic management.

In order to ease the chronic traffic congestion in the BMR, a rapid transit project was initiated in the early 1990s. However, political interference and economic problems caused the processes of planning and construction of the rail system to be slowly implemented. It was not until the late 1990s that the first mass transit system in Bangkok, the Bangkok Mass Transit System (BTS) Skytrain, was introduced. Soon after, the Mass Rapid Transit (MRT) Subway started operations in 2004. These mass transit systems have not only alleviated traffic problems, but also assisted economic development and shaped the urban structure of the BMR.

As of 2013, there are three mass transit systems in the BMR: BTS Skytrain, MRT Subway and Airport Link. The current transit systems, however, are quite limited within the city centre, covering about 71.5 kilometres in length, which comprises only one sixth of the entire plan. Figure 3 shows the current network of mass transit systems in 2010 and the full network which is expected to be completed in 2050, consisting of 12 transit lines and covering around 495 kilometres in length (Nara, 2004; Office of Transport and Traffic Policy and Planning, 2009).

Since the 1960s, Bangkok's urban form has been characterised by automobile-oriented transportation and urban sprawl toward its periphery. Since the emergence of the mass transit systems in the early 2000s, Bangkok urban development has intensified, especially in the inner areas where mass transit is accessible. A great number of new residential developments, for example, can be seen along mass transit routes. Like the impact of road improvement, the impact of the rapid transit systems may affect the values of land in the city, resulting in greater disparities in land prices between land parcels located near mass transit stations and those located farther away.

The impact of proximity to urban amenities and infrastructure on land prices is not always distributed equally. The prices of land in Bangkok and its vicinity have dramatically increased, yet benefiting only a handful of the urban rich, landlords and real estate speculators. This phenomenon is one of the major factors contributing to increasing inequality in the BMR. These well-off people have received great benefits such as higher land values from public infrastructure investment, while other people like the urban poor have to bear a higher cost of rent. Nonetheless, these disparities have not been well understood by many stakeholders such as community residents, planners, policymakers and politicians involved in regional and urban planning in Thailand.

Literature Review

Studies of the Impact of Mass Transit Systems on Property Values

Spatial hedonic models have been widely used in other studies of the impacts of mass transit systems on property values (So *et al.*, 1997; Haider & Miller, 2000; Bae *et al.*, 2003; Armstrong & Rodríguez, 2006; Celik & Yankaya, 2006; Chalermpong, 2007; Agostini & Palmucci, 2008). However, there are very few hedonic studies of the effect of transit accessibility on the residential property market in developing countries due to the limitation of transit investments and the lack of available and reliable data (Chalermpong, 2007).

As shown in Table 1, Chalermpong (2007) summarises the relevant studies on hedonic modelling and accessibility premiums in cities outside North America and Europe. Most of

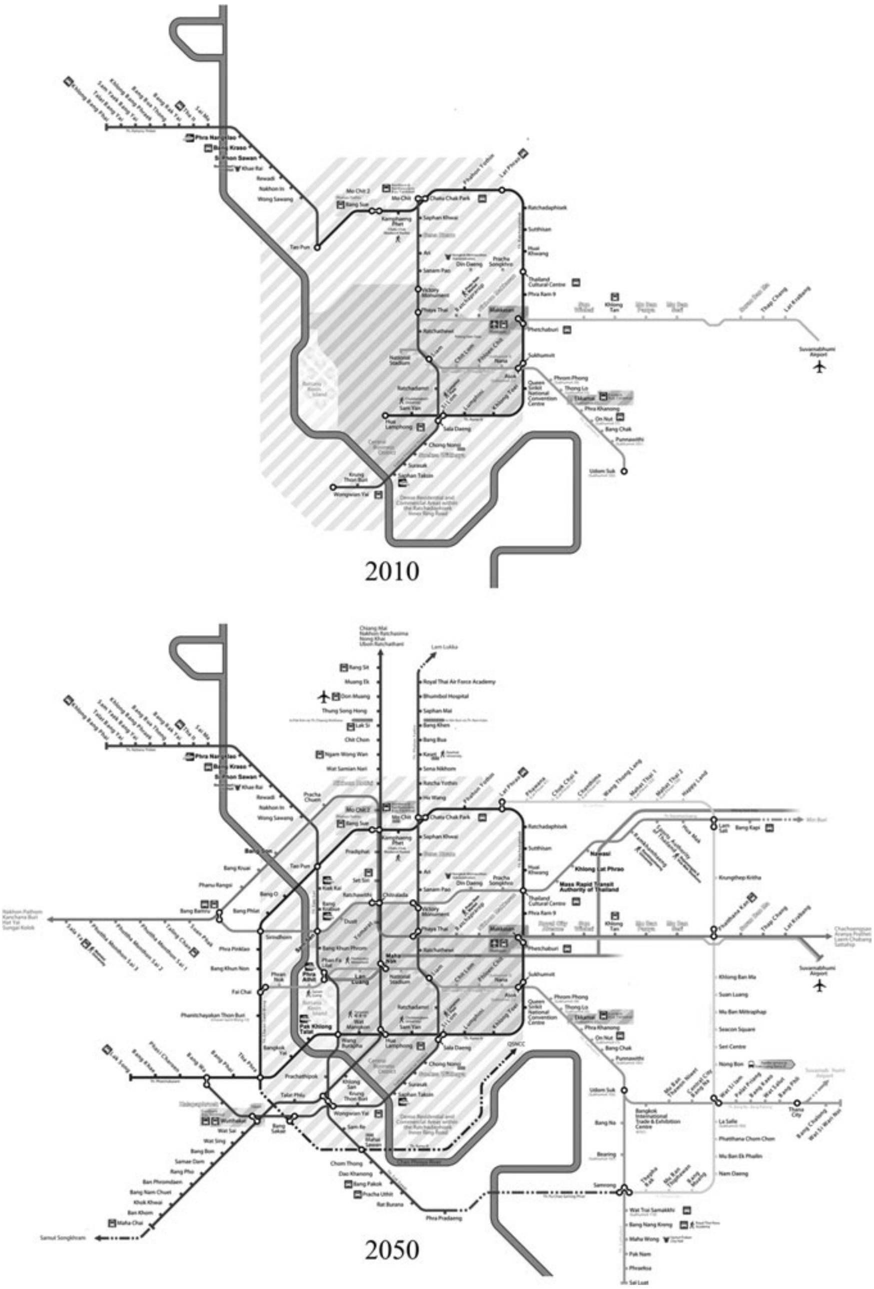

Figure 3. The mass transit systems in the BMR in 2010 and 2050. Source: Adapted from Chatchawal Phansopa (www.2bangkok.com)

the reviewed studies use the Euclidean or straight-line distance from a property location to the nearest transit station as a measure of accessibility. In a linear regression model, the coefficient of the distance can be interpreted as the price premium of being located closer to

Table 1. Summary of hedonic studies outside North America and Europe

Author (publication year)	Study area country	Accessibility premium (distance to nearest station)
Chalermpong (2007)	Bangkok, Thailand	\$10 per metre Elasticity: −0.09
Celik and Yankaya (2006)	Izmir, Turkey	\$4.76–18.70 per metre Elasticity: −0.00011 to −0.00058
Agostini and Palmucci (2008)	Santiago, Chile	\$2–4.57 per metre
Bae *et al.* (2003)	Seoul, South Korea	3 per cent per kilometre Elasticity: −0.16 to −0.22
So *et al.* (1997)	Hong Kong, China	3.3 per cent (if a property is located within 10-min walking distance of station)

Source: Chalermpong (2007).

a transit station. The coefficient is expected to be negative, meaning that the longer the distance, the lower the property value. However, in the case of a log-linear model, the coefficient can be interpreted as price elasticity with respect to the change in distance.

In the case of Bangkok, Chalermpong (2007) studies relationships of BTS stations and property prices in the inner city of Bangkok. He finds that a property price gradient decreases at approximately US\$10 per square metre of liveable area for each additional metre away from BTS stations, and that price elasticity of distance is −0.09. The area studied by Chalermpong (2007), however, covers only a part of the BMR, and the estimated parameters may not reflect the true effects of the proximity to public transit on land values. It is the aim of this study to find the true effects of the proximity to public transit on land value in the entire BMR.

Inequality Caused by Public Infrastructure

Glaeser *et al.* (2009) state that people living in cities where there is inequality tend to be unhappy. They claim that inequality in a city can create higher crime rates, resulting in negative effects on the growth of city-level income and population. Urban inequality can stem from several causes such as differences in human capital (Glaeser *et al.*, 2009) and unequal access to public infrastructure (Calderón & Serven, 2004; Estache, 2006). In developing countries, one of the primary causes of inequality stems from the accessibility to public infrastructure. Ratanawaraha (2010) studied the urban inequality in Bangkok, Thailand. Showing evidence of economic rent-seeking activities created from public infrastructure in the areas around Suvarnabhumi Airport, the new international airport in the BMR, he found that only some groups of people receive benefits from urban infrastructure investment.

The concept of rent seeking was originated by Gordon Tullock in 1967. Economic rent seeking starts with economic intervention by a government biased toward special interests. Politicians and policymakers create economic rents by rewarding special interests with favoured treatment or burdening their competitors with restrictions. This activity is the result of poor transparency and bad governance in development plans. It not only increases the cost of development and investment but also creates uneven distribution of public improvement. Only some groups of people receive benefits from higher land value. In the case of land value, theoretically, the value of land increases when development of nearby urban infrastructure occurs. This development is done by using taxes or public money and should be paid back to society because it is an unearned increment or an additional value that is not created from a personal investment. This, however, is not the case in Thailand. The mechanism of value-capture taxation is neither well developed nor effectively implemented, resulting in unfairness between landowners who gain higher land value and taxpayers who pay for public investments (Ratanawaraha, 2010). In this article, the framework for applying a value-capture mechanism to residential land taxation is presented and discussed later in the policy implication section.

Data and Methodology

The database for spatial hedonic regressions in this study is drawn from two major data sets: residential land prices from the Real Estate Information Center (REIC) and geographic information systems (GIS) data from the Department of Public Works and Town & Country Planning. The data from the REIC are market prices of residential land in real estate projects in the BMR. This study uses market prices instead of official appraisal property values for many reasons. In Thailand, access to the official database of property values from the Department of Land is limited due to confidentiality concerns. Furthermore, the property value database may not be reliable since the data are sometimes based on an outdated property appraisal value. Rather, a transaction value or a market price is more appropriate to represent the real value of land and is a better indicator for evaluating value changes in residential land use. Thus, the data used in this study are market prices rather than official appraisal prices.

Residential Land Price

The data of all single-family residential development projects in Thailand are collected by the REIC. A single-family residential development project is a residential project developed by a real estate developer. A residential unit is occupied by a single family and includes a land parcel (with or without a house). In 2010, there were 684 on-market residential real estate projects in the BMR. The data include developers' names, locations, property prices, land prices, number of housing units, number of units sold, average housing areas and average land areas. In Thailand, the unit of land area is measured in 'Tarang Wah' or square wah, which is approximately 4 square metres or 43.0556 square feet or 0.000988 acres. In this study, US$1 equals 30 Baht.

The descriptive statistics of the attributes of residential development projects in the BMR are shown in Table 2. While the average prices of property in the data range from

Table 2. The descriptive statistics of REIC data in 2010 (number of observations = 684)

Variables	Median	Mean	Std. dev.	Min	Max
Property price (Baht)	2 890 000	4 014 281	5 663 603	190 000	79 500 000
Land price (Baht)	30 000	35 110	19 876	3000	217 500
Number of housing units	76	117	136	4	1465
Number of units sold	42	75	107	0	1453
House area (sq. m)	42	53	49	35	650
Land area (sq. wah)	150	164	90	18	815

Source: Authors' calculation, Real Estate Information Center (2011).

190 000 Baht (US$6333) to 79 500 000 Baht (US$2 650 000), the average prices of land in the data range from 3000 Baht per square wah (US$2.32 per square foot) to 217 500 Baht per square wah (US$168 per square foot). The average land price is 35 110 Baht per square wah (US$ 27.18 per square foot). The distribution of average land price per square wah in the BMR is shown in Figure 4.

The real estate projects in the BMR generally are developed by various types of developer, ranging from entrepreneurs who use their personal investments to finance small-scale projects to international public companies investing in mega projects. As can be seen in Table 2, the number of units in a project ranges from 4 to 1465. The usable area or house area and land area represent a variety of residential products from a compact townhouse to a spacious mansion on a large plot of land. The average house areas are 53 square metres (412.62 square feet) and the average land areas are 164 square wah (7061.84 square feet or 0.16 acres).

Figure 5 illustrates the land prices of single-family residential land development projects in 2010 in the BMR. The average price of residential land in a real estate project ranges from under 1000 Baht per square wah (US$0.77 per square foot) to more than 150 000 Baht per square wah (US$116 per square foot). As shown in the figure, the average price is represented in a range from light grey (low) to dark grey (high).

The spatial distribution of locations of single-family residential projects in 2010 is also shown in Figure 5. Most of the residential developments are located outside the inner ring road of the BMR; out of 684, only 5 projects are located within the inner ring road. As shown in Figure 5, the clusters of residential projects can be visually observed along the outer ring road, especially in the eastern and western areas of the BMR. A cluster of high-priced land can be found in the east outside the inner ring road.

As mentioned earlier about the availability and reliability of the database from the Department of Land, the data used in this study are the transaction prices of residential land development. The observations in the data set are average prices of land in residential land development projects which comprise the subpopulation of all residential real estate projects in the market in the BMR in 2010. In addition, REIC reports that newly built residential property transactions accounted for 70 per cent of all residential transactions in the BMR in 2010. Thus, residential land values in this data set are representative of residential land values in the city.

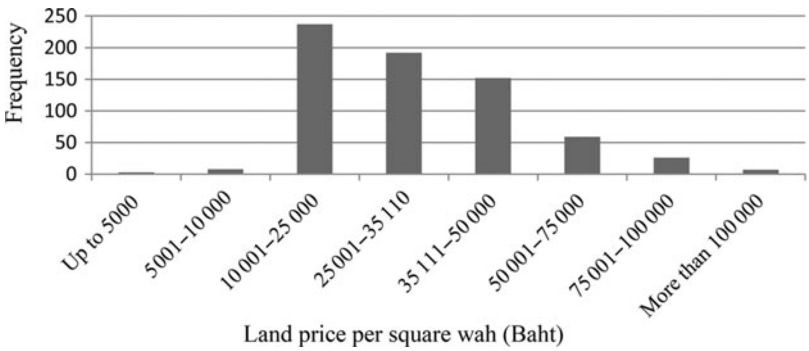

Figure 4. The distribution of average land price per square wah

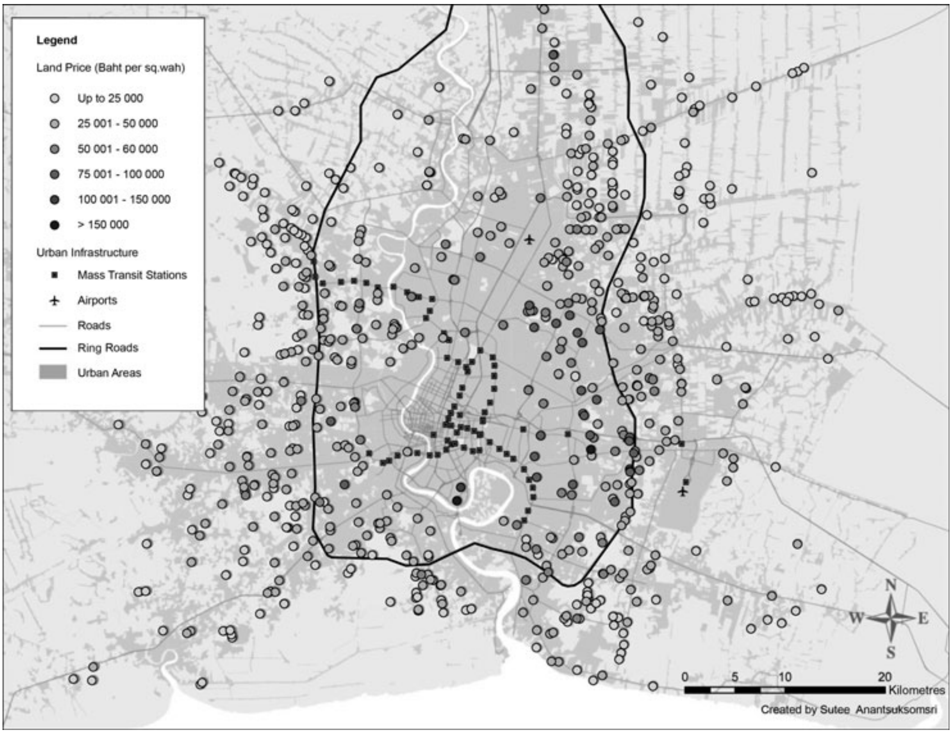

Figure 5. The spatial distribution of land price of single-family residential development projects in the BMR in 2010

GIS Data of the BMR

The GIS data include the locations of urban infrastructure and amenities in the BMR such as road networks, mass transit stations, airports, hospitals, public parks, top schools, universities and shopping malls. With GIS data, population density is calculated at the sub-district level, as well as all the distance variables, using ArcGIS® software. As shown in Figure 6, most residential projects are located in sub-districts with a high population density represented in darker grey. The density of population can also represent the density of public infrastructure in the BMR.

Table 3 summarises the descriptive statistics of single-family residential real estate development projects, population density in a sub-district where the project is located and distances from the project to public amenities in the BMR in 2010. The average population density of these sub-districts is 951 people per square kilometre. The population density ranges from 8 to 3666 people per square kilometre. The range of the population density is very wide since the BMR by definition includes the less-populated agricultural areas in Pathum Thani and heavily populated residential and commercial areas in Bangkok.

The central business district (CBD) is usually referred to as the area in the sub-district of Lumphini. In this study, the CBD is located at the south-east corner of Lumphini Park at the intersection of Rama IV Road and Ratchadamri Road. As mentioned earlier, most single-family residential projects are located outside the inner ring road. The average distance from a project to the CBD is approximately 23 kilometres.

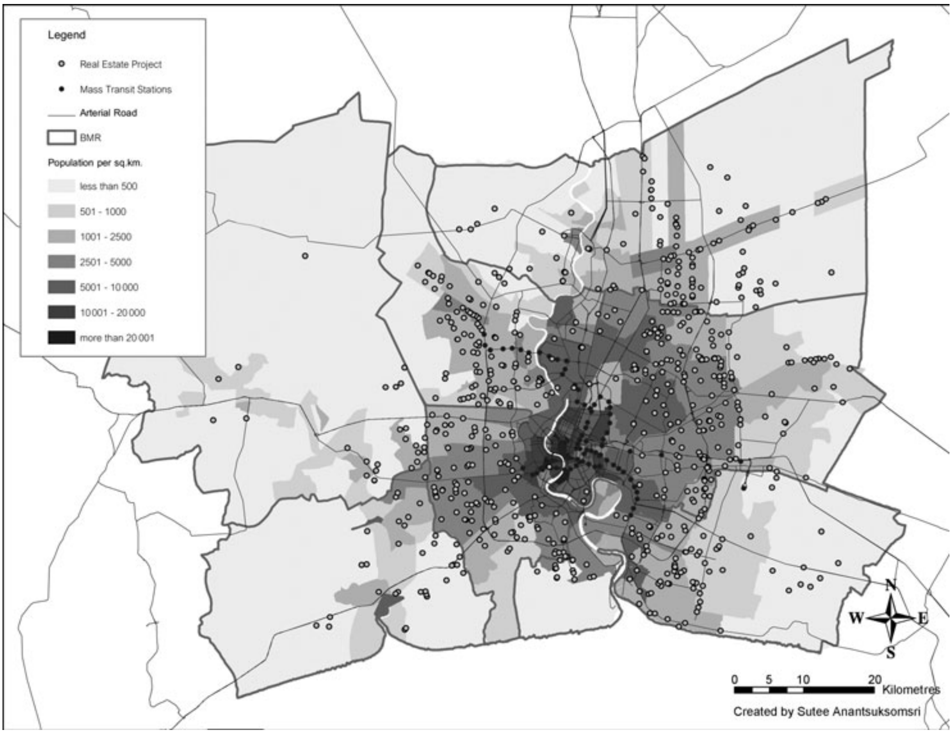

Figure 6. Population density in the BMR

The distribution of land price by distance to the city centre in Figure 7 also illustrates that a land parcel located further from the city centre has a lower price. The slope of land price decreases gradually from the city centre, supporting earlier findings that Bangkok is a monocentric city (Wisaweisuan, 2001). However, there are two small spikes at the ranges of 11–13 and 35–45 kilometres away from the city centre. The slope of land price

Table 3. The descriptive statistics of residential projects in the BMR in 2010 (number of observations = 684)

Variables	Median	Mean	Std. dev.	Min	Max
Land price	30 000	35 330	20 716	3000	217 500
Number of housing units	76	117	136	4	1465
Population density	853	951	716	8	3666
Distance to					
CBD	22 011	23 374	9006	3655	65 140
Arterial road	1057	1427	1486	1	10 144
Mass transit station	10 627	11 875	8107	222	46 141
Airport	31 212	30 478	14 391	4492	88 701
Hospital	2871	3717	3764	58	35 535
Public park	3952	5231	4841	111	46 767
Top school	2951	4016	4217	190	44 491
University	6130	7019	5046	616	47 260

Source: Authors' calculation.

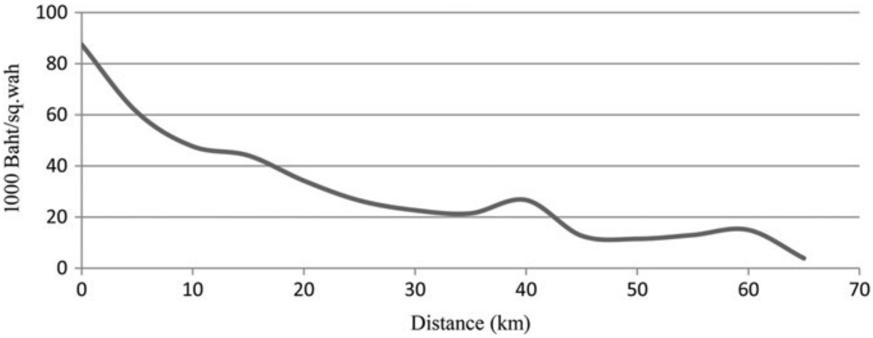

Figure 7. Average land price by distance to the city centre of the BMR

in this figure conforms to the actual physical configuration of the inner and outer ring roads which are located at approximately 12 and 40 kilometres from the city centre.

As shown in Table 3, the average distance from a project to an arterial road is approximately 1.4 kilometres. While the closest distance from a project to an arterial road is 1 metre, the farthest distance is around 10 kilometres. The distribution of land price by distance to an arterial road in Figure 8 illustrates that a parcel of land located further from a road has a lower price. The slope of land price within the distance of 0–5 kilometres is steeper than the slope within the distance of 5–7 kilometres, suggesting that the impact of the road to the land price is higher within 5 kilometres. The flat slope within the distance of 5–7 kilometres may suggest that the impact is very low. The prices of land located within these distances are relatively similar.

Figure 9 shows that the price of residential land decreases when the land is located away from a mass transit station. The slope of land price is slightly flat within the distance range from 0 to 5 kilometres, suggesting that prices of residential land located within a travelling distance of approximately 15 minutes to a mass transit station arterial road are relatively similar. The steeper slope with the distance of 5–20 kilometres may indicate the high impact of proximity to a mass transit station on the land price. Within these distances, the land price declines sharply when the land is located away from a mass transit station.

As illustrated in Figure 10, the price of residential land tends to decrease when the land is located away from urban amenities such as hospitals, parks, schools and universities.

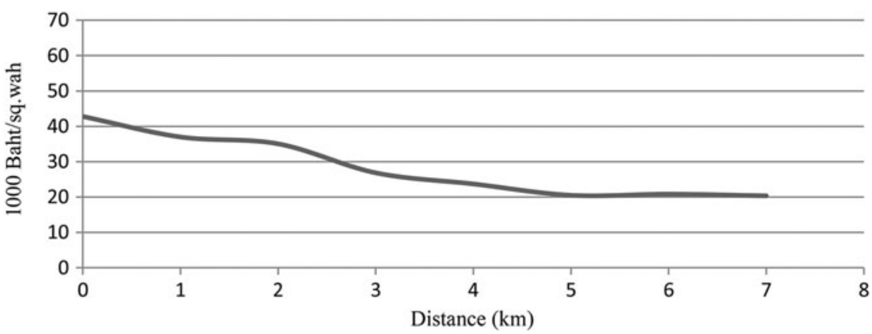

Figure 8. Average land price by distance to arterial road in the BMR

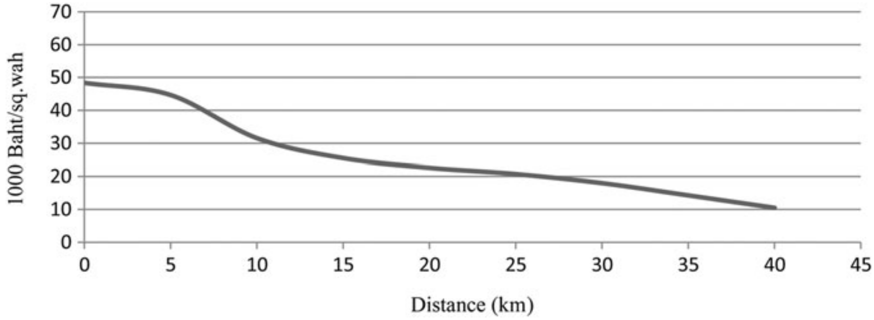

Figure 9. Average land price by distance to mass transit station in the BMR

The price of land adjacent to or located less than 1 kilometre from a hospital or school is lower than the land price located 1 kilometre away. This may suggest that living too close to a hospital or school is not desirable. On the other hand, the price of land dramatically declines if the land parcel is located farther from a university, especially within the first kilometre. This may suggest that living close to a higher education institute is more preferable than living close to a school.

Model Specification and OLS Estimation

The analysis of land prices in the BMR under a hedonic modelling framework begins with the specification of an ordinary least squares (OLS) model, which is the base model of this study. After the hedonic OLS model is specified, spatial autocorrelation is examined. If spatial autocorrelation is found to be significant, spatial hedonic models are employed. The dependent variable is land price per square wah. Out of 684 observations, 62 outliers and missing data are excluded, leaving 622 observations for the estimation. The independent variables are categorised into three main groups: (1) real estate project

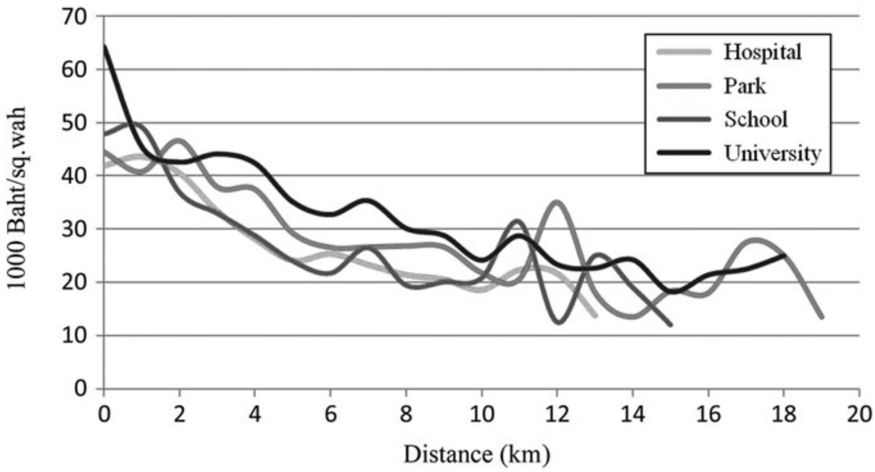

Figure 10. Average land price by distance to urban amenities in the BMR

characteristics, (2) location characteristics and (3) proximity to public infrastructure. The characteristics of real estate projects include number of housing units, number of units sold, average house area and land area. The population density of the sub-district in which a real estate project is located is considered as a location characteristic.

Proximity to public infrastructure is measured by the Euclidean distance from a location of a real estate project to locations of the nearest public amenities such as mass transit stations, major roads, CBD, airports, hospitals, public parks, top schools and universities. These distances may not all be present in a regression model since it violates the *ceteris paribus* assumption. Thus, only the distance to the nearest mass transit station is used as a continuous distance. The other distances are classified into distance bands based on the distribution of proximity to each type of public amenity.

The proximity to the nearest arterial road is categorised into five distance bands: (1) less than 100 metres, (2) between 100 and 500 metres, (3) between 500 and 1000 metres, (4) between 1 and 5 kilometres, and (5) farther than 5 kilometres. On the other hand, the range of distances to the CBD and the nearest airport, hospital, public park, top school and university is wider than the proximity to the nearest arterial road. The distances to the nearest hospital, park, school and university are grouped into three distance bands: (1) less than 1 kilometre, (2) between 1 and 5 kilometres, and (3) farther than 5 kilometres. In addition, the proximity to the CBD and the nearest airport is divided into three distance bands: (1) less than 10 kilometres, (2) between 10 and 20 kilometres, and (3) farther than 20 kilometres.

The hedonic OLS model is specified as follows:

$$Y = \beta_0 + X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + \varepsilon \tag{1}$$

where Y is an $N \times 1$ vector of land price per square wah

β_0 is an $N \times 1$ vector of an intercept
X_1 is an $N \times K_1$ matrix of real estate project characteristic variables
β_1 is a $K_1 \times 1$ vector of a coefficient of X_1
X_2 is an $N \times K_2$ matrix of population density of a sub-district in which a real estate project is located
β_2 is a $K_2 \times 1$ vector of a coefficient of X_2
X_3 is an $N \times K_3$ matrix of proximity to public infrastructure variables
β_3 is a $K_3 \times 1$ vector of X_3
ε is an $N \times 1$ vector of random errors
K is the number of explanatory variables ($K_1 = 4$, $K_2 = 1$, $K_3 = 8$) and
N is the number of observations (622 observations).

Several tests were performed during the model selection process including the Bayesian information criterion (BIC), Akaike's information criterion (AIC) and the test of multicollinearity. The model selection tests suggest the following explanatory variables: (1) distance to the nearest mass transit station, (2) sub-district population density, and dummy variables of distances to (3) arterial roads, (4) CBD, (5) airports, (6) hospitals, (7) public parks, (8) top schools and (9) universities. Appendix A shows the test results for multicollinearity. None of the variance inflation factors (VIFs) of predictor variables is greater than 10, and the average VIF is 2.36, suggesting no serious multicollinearity.

Testing for Spatial Autocorrelation

In addition to the OLS estimation, spatial autocorrelation is examined. As illustrated in Figure 5, the geographic cluster of land prices can be visually inspected. To formally identify the presence of spatial autocorrelation, a significant value for Moran's *I*-statistic is tested. While the significance of Moran's *I* signals the presence of spatial autocorrelation, the magnitude of Moran's *I* represents the extent of spatial autocorrelation based on the spatial weight matrix. The specified spatial weight matrix criterion that yields the largest value of Moran's *I* will be selected. In this study, distance (inverse distance) is selected as the criterion for constructing the spatial weight matrix since the observations are point locations of residential land. After multiple significance tests calculating Moran's *I*-statistic for different distance bands, the results indicate that at 18.8 kilometres, Moran's *I*-statistic is significant and has the highest magnitude at 0.333 where all observations are included and have at least one neighbour (see Figure 11). Thus, the distance is used as a threshold to construct the spatial weight matrix, which will be later used in both spatial lag and spatial error models.

Estimation of Spatial Hedonic Models

The spatial hedonic regressions undertaken in this study include spatial lag and spatial error models. To choose the most appropriate model of these two, the hypothesis test of autoregressive coefficients is conducted. In order to test spatial lag dependence, the Lagrange multiplier (LM) is used to test the null hypothesis, $\rho = 0$:

$$LM(lag) = \frac{\left(\frac{\varepsilon' WY}{\sigma^2}\right)^2}{\frac{(WX\beta)' MWX\beta}{\sigma^2} + tr(W'W + W^2)}, \tag{2}$$

where M is the projected matrix, $I - (X(X'X) - 1X')$, and $\sigma^2 = \frac{\varepsilon'\varepsilon}{N}$.

In order to test spatial error dependence, the LM is used to test the null hypothesis, $\lambda = 0$:

$$LM(error) = \frac{\left(\frac{\varepsilon' WY}{\sigma^2}\right)^2}{tr(W'W + W^2)} \tag{3}$$

Based on the LM test of two models, if one of two statistics is significant, the model with the most significant LM statistic will be selected. In the case that neither of the statistics is significant, the spatial dependence hypothesis is rejected, indicating that the OLS model is sufficient for the hedonic regression. On the other hand, if both statistics are significant, the robust LM statistic test needs to be performed and compared. The preferred model is the model with the larger value of the robust LM statistic (Anselin *et al.*, 1996).

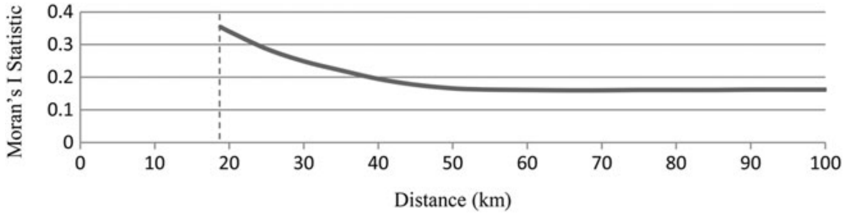

Figure 11. Moran's *I*-statistic by distance criterion specified in the spatial weight matrix

The Impact of Mass Transit on Residential Land Value

Regression Models

The results of spatial diagnostics are shown in Table 4. As can be seen, both models give significant LMs, indicating the significant presence of spatial autocorrelation. This significance suggests that OLS is not an appropriate model. The results also indicate that only the LM of spatial lag is significant. Thus, the spatial lag model is selected as the preferred model. The regression results of OLS regression, spatial error and spatial lag models are shown in Table 5. Since the robust LMs suggest that spatial lag is the most suitable model, only estimation results from the spatial lag model are discussed.

As shown in Table 5, the coefficient of the distance to the nearest mass transit station is negative and statistically significant as expected. This coefficient implies that the price per square wah of residential land development decreases at 0.283 Baht per square wah (approximately US$0.0002 per square foot) for each additional metre away from a mass transit station. In other words, the value of 1 acre of residential land development (which equals 1000 square wah) located 1 kilometre away from the nearest mass transit station will be US$9210 (283 000 Baht) lower than identical land located adjacent to the mass transit station.

The coefficient of population density is positive and significant. As mentioned earlier, population density can also represent urban infrastructure density. The denser population implies higher infrastructure improvement. This result confirms that there is a positive effect of urban infrastructure on the value of residential land development. The proximity to public amenities such as major roads, airports, public parks and universities has a significant positive impact on land values. According to the results, the impact is greater the closer the land is to these public amenities.

The coefficients of the dummies of distance to arterial roads are smaller as the distance bands are further out. The impact of being located within 100 metres from roads is 7429 Baht per square wah (US$5.8 per square foot), while that of 100–500 metres is 6138 Baht per square wah (US$4.79 per square foot). In addition, the impact is less significant for the 500 metres to 1 kilometre distance and eventually becomes not significant for land located more than 1 kilometre away from major roads.

Similar to the impact of proximity to major roads, the coefficients of the dummies of distance to airports, public parks and universities become smaller and less significant as a property is located farther away from these infrastructures. On the other hand, the impacts of proximity to hospitals and schools are found to be not significant. As mentioned earlier, living too close to a hospital or school may not be desirable to local residents due to increased noise and traffic related to those places.

Table 4. Spatial diagnostics

Test	Statistic	df	*p*-value
Spatial error:			
Lagrange multiplier	16.251	1	0.000
Robust Lagrange multiplier	1.058	1	0.304
Spatial lag:			
Lagrange multiplier	17.667	1	0.000
Robust Lagrange multiplier	2.204	1	0.138

Source: Authors' Calculation.

Table 5. Regression results of different models of land value determinants

Variables	OLS	Spatial error	Spatial lag
Distance to mass transit station	− 0.41***	− 0.47***	− 0.28***
	(− 7.1)	(− 5.4)	(− 4.4)
Population density	2.60***	2.14***	2.13***
	(4.4)	(3.2)	(3.6)
Dummy of distance to arterial roads			
Less than 100 metres	8443.27***	6983.73***	7429.05***
	(4.4)	(3.4)	(4.0)
Between 100 and 500 metres	7097.36***	5787.01***	6137.64***
	(3.7)	(2.8)	(3.3)
Between 500 and 1000 metres	4453.00**	2774.19	3566.74*
	(2.3)	(1.4)	(1.9)
Between 1 and 5 kilometres	2640.65	1114.92	1883.64
	(1.5)	(0.6)	(1.1)
Dummy of distance to CBD			
Less than 10 kilometres	12 796.05***	12 056.43***	11 113.20***
	(5.8)	(4.9)	(5.1)
Between 10 and 20 kilometres	5158.30***	4728.77***	3928.94***
	(5.5)	(4.2)	(4.1)
Dummy of distance to airport			
Less than 10 kilometres	5406.72***	4229.91**	3180.39**
	(3.5)	(2.1)	(2.0)
Between 10 and 20 kilometres	3844.25***	3507.60***	2507.01**
	(4.0)	(2.7)	(2.6)
Dummy of distance to hospitals			
Less than 1 kilometre	− 267.30	850.53	149.67
	(− 0.2)	(0.5)	(0.1)
Between 1 and 5 kilometres	− 813.82	323.94	− 435.04
	(− 0.7)	(0.3)	(− 0.4)
Dummy of distance to park			
Less than 1 kilometre	7621.49***	7994.61***	7348.48***
	(3.8)	(3.9)	(3.8)
Between 1 and 5 kilometres	1611.87*	1690.24*	1486.13
	(1.7)	(1.7)	(1.6)
Dummy of distance to school			
Less than 1 kilometre	915.36	365.80	465.25
	(0.5)	(0.2)	(0.3)
Between 1 and 5 kilometres	2137.41**	1803.16	1549.76
	(2.0)	(1.5)	(1.5)
Dummy of distance to university			
Less than 1 kilometre	12 240.25***	11 254.95***	11 525.79***
	(3.4)	(3.2)	(3.3)
Between 1 and 5 kilometres	3558.95***	3203.86***	2992.45***
	(4.2)	(3.5)	(3.6)
Constant	22 477.92***	24 848.23***	11 266.18***
	(10.8)	(9.4)	(3.4)
λ-Constant		0.50***	
		(4.5)	
σ-Constant		8122.81***	8154.67***
		(35.0)	(35.2)
ρ-Constant			0.39***
			(4.3)
***R*-squared**	0.561		
N	622	622	622

Notes: *t*-statistics in parentheses
***, ** and * indicate coefficient estimates that are statistically significant at 0.01, 0.05 and 0.1 confidence levels, respectively.
Source: Authors' calculation.

The results strongly suggest that, in addition to distances to CBD and arterial roads, distances to mass transit stations have significant impacts on the land value of residential developments in the BMR. Undoubtedly, it is the owners of land adjacent to mass transit stations who enjoy the increase in land values from the capital-intensive public investment in infrastructure, and the benefits from these investments may not be evenly distributed. Since currently there is no tax on residential land implemented in Thailand, a certain kind of taxation policy that can 'capture' these increased values of residential land should be put into effect. Further, as discussed earlier, the assessed land values are outdated and unreliable, so the procedure of land value assessment currently in use should be adjusted to internalise locational advantages such as proximity to public amenities and public transit stations, thereby reflecting the real values of residential land.

Policy Implication on Land Value Taxation in Thailand

Policy Implication on Property Tax

Currently, there are two different types of tax levied on property in Thailand: land tax and structure tax. The annual land tax levied on land ownership is very small. In practice, property owners rarely pay it annually. They usually pay it after several years when the amount has accumulated. An annual structure tax is only applied to commercial use properties. Unlike many developed countries, property taxes are not a main source of income for the local government in Thailand. The main income from property is from the property transaction fee, which is incurred whenever a property is bought or sold.

There are three potential taxes or fees to be paid in the property transaction, depending on the details of the transaction. It is also important to note that most of the fees are calculated based on the official assessed value of the property and, as mentioned earlier, this value is usually well below the market value. The descriptions of taxes and fees are as follows:

1. A transfer fee is based on the appraised value of the property and is normally shared equally between both buyer and seller.
2. A stamp duty is based on the official appraised value or the contracted price, whichever is higher.
3. If the seller is a company, a withholding tax (WHT) on the sale of the property is calculated at 1 per cent of the official appraised value or the contracted price, whichever is higher. If the seller is an individual, the WHT is based on the individual's marginal tax rate after deducting from the official appraisal price a standard deduction based on the number of years of ownership.

In fact, there have been several attempts to improve the property tax mechanism in Thailand. These attempts were not approved by the House of Representatives since many politicians are major landlords in the country (Ratanawaraha, 2010). However, the property taxation mechanism in Thailand needs to be re-engineered. Accordingly, the mechanisms of property tax, property gains tax and special assessment levy should be improved. A well-managed taxation structure cannot only provide higher income to the government but can also control speculation on land value via a property gains tax. Further, these taxation mechanisms may result in less inequality in the country.

Ratanawaraha (2010) suggests that many developed countries such as Japan and Germany have been successful in using a property gains tax and betterment tax to decrease inequality and prevent rent-seeking activities.

There are two basic methods for calculating betterment assessments: the ‘fixed uniform rate’ method and the ‘uniform unit’ method. The ‘fixed uniform rate’ applies an amount of tax levies to every property owner equally regardless of the size or other attributes of the property (Town of Chelmsford, 2008). On the other hand, the ‘uniform unit’ method distributes the tax levies proportionally to the size or other attributes of the property. The timing of the assessment usually corresponds to the completion of the project, and this betterment assessment is a one-time tax which can be paid in one lump sum or in multiple-year apportionment.

In this study, to illustrate the mechanism of a proposed betterment tax, the estimated parameters from the spatial hedonic regression model are used to calculate the amount of proposed taxation on capital gains from the higher value of land as a result of public investment in infrastructure. The area near the proposed mass transit line, State Railway of Thailand (SRT) Dark Red Line, is selected as a case study. The SRT Dark Red Line is a suburban railway system serving the northern part of the BMR. The length of the system is 26 kilometres. The system is a combination of elevated and on-ground structures. The stations and surrounding area will develop the capacity for a commuter train and northern long-distance train projects. The construction of the SRT Dark Red Line project was approved in 2006 with a budget of 55 220 million Baht (US$1840 million). The specific locations of mass transit stations have been selected. The project is under construction and expected to operate in 2019 (Office of Transit and Traffic Policy and Planning, 2009).

The procedures on how to implement the spatial hedonic model for estimating a proposed betterment tax are as follows:

1. spatial referencing locations of SRT Dark Red stations and recalculating the distance from the land to the nearest stations which include proposed SRT Dark Red Line stations;
2. estimating a change in land value, assuming that the land with a shorter distance to the nearest station gains a higher value, *ceteris paribus*, using parameters from the spatial hedonic model; and
3. calculating a betterment tax in the selected area.

The first step is to spatially reference the locations of the new SRT Dark Red stations by transforming the latitude and longitude coordinates of the stations’ locations into point features on a map. As shown in Figure 12, there are 24 062 residential units in 171 real estate projects located in the northern part of the BMR in 2010 which will gain higher land values as a result of positive externalities from the proposed mass transit line. If the SRT Dark Red Line operates, the proximity to the nearest mass transit station of these projects will be increased. Thus, the distances to the nearest station for these projects need to be recalculated.

As illustrated in Figure 13, as a new Dark Red Line station becomes the nearest station to these projects, the new distance, d_1, will be shorter than the distance to the existing nearest station, d_0. The values of land in these projects are expected to be higher due to the shorter distance to the nearest mass transit station, *ceteris paribus*. Therefore, the change in land value is affected only by the change of distance to the nearest station. In the second step, the estimated parameters from the spatial hedonic regression model are used to calculate the amount of change in land value. Formally, the land value gain from the SRT Dark Red Line can be computed as follows:

$$\Delta Y = (d_1 - d_0)\beta_{Dtransit}, \tag{4}$$

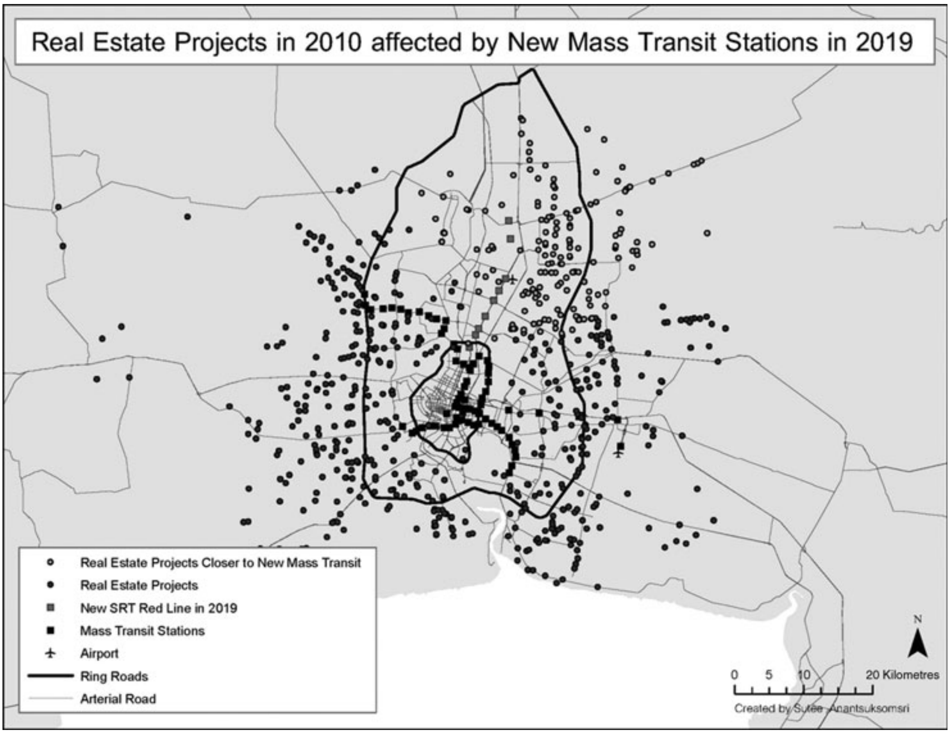

Figure 12. The locations of projects affected by SRT Dark Red Line station

where ΔY is a change in land value per square wah

d_0 is the distance to the nearest existing mass transit station
d_1 is the distance to the nearest new mass transit station and
β_{DM} is a $K_1 \times 1$ vector of a coefficient of X_1.

In the last step, the betterment tax is then calculated based on the capital gains from the increasing land value. The number of residential units in this study, however, is only a portion of the total housing units in the selected area. The total capital gains of the

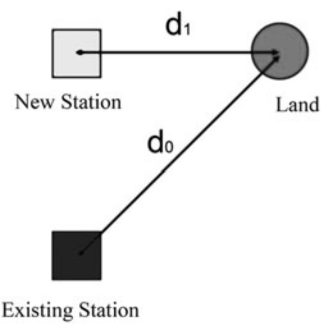

Figure 13. A change in proximity to the new mass transit stations from land

residential land in real estate projects in the selected area are 2434 million Baht. This amount of capital gains is an example of a betterment tax base for single-family residential land in real estate projects. The appropriate betterment assessment method for this mass transit project is the 'uniform unit' method that proportionally distributes tax levies to a land area. In practice, the determination of betterment levies usually involves agreements among several parties such as the government, public infrastructure agencies, residents and landowners. However, there are controversies around the implementation of a betterment tax since some public infrastructures such as airports or waste management facilities may not be considered desirable to every resident. Another controversial issue is the justification for the assessment. Thus, transparency and public participation in the betterment assessment procedures are essential for a successful and effective property tax policy. This betterment tax may be used as one tool to introduce property tax reforms. It would be one step toward greater equality in Bangkok and in Thailand at large.

Conclusion

This study employs spatial hedonic regression models of the land value of residential developments in the BMR. Among OLS regression, spatial lag and spatial error models, the spatial lag model is selected as the preferred model. According to the results, it is clear that the mass transit improvements have contributed to an increase in residential land development prices. The results of this study have direct implications for property tax policies and land value assessment mechanisms.

This study also introduces the implementation of a capital gains tax from higher land value. The scenario of the increasing land value in the area near the proposed SRT Dark Red Line is illustrated as a case study. The parameter estimates from the spatial hedonic model can be used to calculate capital gains on increased land value due to public investment in infrastructure given the attributes of a property location. The implementation of a betterment tax would not only benefit local and national governments through higher revenues, but also to some extent discourage economic rent seeking or speculative activities. The betterment tax is also one of the mechanisms that could reduce inequality of land value benefits in the country.

Depending on the availability of the data, further studies could include examining the effects of proximity to public amenities on land values of different kinds of land use such as those for commercial and retail uses. In addition, other types of publicly accessible amenities, for example, police stations and fire stations, should be included as additional explanatory variables. Furthermore, at the end of 2011, Thailand experienced the worst flood in decades, which caused millions of Baht in damage. Many provinces in Thailand, including Bangkok, were basically underwater. After this devastating natural disaster, the price of properties in 'safe' areas in Bangkok rose considerably, while the price of properties in flooded areas plunged. Therefore, topographical features such as elevation should also be included in a future study.

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Appendix A: Test of Collinearity among explanatory variables

Variable	VIF	1/VIF
Distance to mass transit station	1.98	0.504283
Population density	1.48	0.674984
Dummy of distance to arterial roads		
Less than 100 metres	4.5	0.222453
Between 100 and 500 metres	3.95	0.253331
Between 500 and 1000 metres	4.5	0.222206
Between 1 and 5 kilometres	6.63	0.150882
Dummy of distance to CBD		
Less than 10 kilometres	1.27	0.789251
Between 10 and 20 kilometres	1.7	0.586861
Dummy of distance to airport		
Less than 10 kilometres	1.23	0.81333
Between 10 and 20 kilometres	1.29	0.778132
Dummy of distance to park		
Less than 1 kilometre	1.37	0.731855
Between 1 and 5 kilometres	1.89	0.529082
Dummy of distance to hospitals		
Less than 1 kilometre	1.71	0.585438
Between 1 and 5 kilometres	2.15	0.465289
Dummy of distance to schools		
Less than 1 kilometre	2.01	0.498311
Between 1 and 5 kilometres	2.26	0.441603
Dummy of distance to university		
Less than 1 kilometre	1.1	0.911538
Between 1 and 5 kilometres	1.46	0.683324
Mean VIF	**2.36**	