# HOW FAR FROM THE TRAIN STATION SHOULD WE TAX? AN EMPIRICAL STUDY BASED ON VALUE CAPTURE METHOD

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# แนวทางการประเมินภาษีบนที่อยู่อาศัยในรัศมีขอบข่ายโครงสร้างพื้นฐานระบบราง งานศึกษาเชิงประจักษ์ด้วยวิธีการตรวจจับมูลค่า

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งานวิจัยชิ้นนี้ต้องการนำเสนอแนวทางการแสวงหารายได้ให้กับรัฐบาล ผ่านการขยายฐานภาษีกลุ่มทรัพย์สิน ด้วยการจัดเก็บภาษีจากเจ้าของสินทรัพย์ ที่ได้รับผลประโยชน์จากมูลค่าที่เพิ่มขึ้นในการพัฒนาโครงสร้างพื้นฐานของภาครัฐ มีวัตถุประสงค์สำคัญ 2 ประการ คือ ประการแรก ผู้วิจัยต้องการวิเคราะห์ผลกระทบทางเศรษฐกิจที่เกิดขึ้นจากการมีอยู่ของสถานีรถไฟฟ้า รวมทั้งปัจจัยอื่นๆต่อมูลค่าของที่อยู่อาศัย ประการที่สอง ผู้วิจัยต้องการนำแนวคิดการตรวจจับมูลค่าไปใช้สร้างแบบจำลองทางภาษี สำหรับกลุ่มตัวอย่างคือ อสังหาริมทรัพย์ประเภทที่อยู่อาศัย ที่ตั้งอยู่ภายในรัศมี 2 กิโลเมตรตามแนวถนน จากสถานีรถไฟฟ้าสายสีน้ำเงินที่ตั้งอยู่ใกล้ที่สุด จำนวน 511 อาคาร โดยเครื่องมือที่ใช้ในงานวิจัยชิ้นนี้ ได้แก่ (1) แบบจำลองราคาเฮโดนิก (Hedonic Pricing Model) นำมาเพื่อประเมินความสัมพันธ์ของตัวแปรด้านต่างๆที่มีต่อมูลค่าของสินทรัพย์ และ (2) แบบจำลองเศรษฐมิติเชิงพื้นที่ (Spatial Econometrics) นำมาเพื่อใช้แก้ไขปัญหาสหสัมพันธ์เชิงพื้นที่ (Spatial Autocorrelation) และเพิ่มความแม่นยำในการประมาณการ

ผลการศึกษา พบว่า มีเพียงอสังหาริมทรัพย์ที่อยู่อาศัยที่ตั้งอยู่ภายในระยะทาง 0-400 เมตรจากสถานีรถไฟฟ้าเท่านั้นที่ได้รับอิทธิพลผ่านราคาที่เพิ่มสูงขึ้น และจะสูงมากขึ้น หากสถานีนั้นเป็นชุมทางเชื่อมต่อเส้นทางรถไฟฟ้ามากกว่าหนึ่งสาย (Interchange Station) ขณะที่ความง่ายในการเข้าถึงพื้นที่สาธารณะ และความเข้มงวดจากการบังคับใช้กฎหมายสิ่งแวดล้อม ต่างล้วนมีผลทำให้ระดับราคาอสังหาริมทรัพย์สูงขึ้นเช่นกัน และท้ายสุด จากแบบจำลองภาษีระบุว่า หากรัฐบาลดำเนินการเก็บภาษีรูปแบบก้าวหน้า คาดว่าประเทศจะมีเงินอุดหนุนการก่อสร้างโครงสร้างพื้นฐาน เพิ่มขึ้นประมาณ 34.63-173.15 ล้านบาท



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KEYWORD: Urban Transportation, Windfall Tax, Hedonic Pricing Model, Spatial Econometrics

Nanthawat Ouysinprasert : HOW FAR FROM THE TRAIN STATION SHOULD WE TAX? AN EMPIRICAL STUDY BASED ON VALUE CAPTURE METHOD. Advisor: Asst. Prof. Athiphat Muthitacharoen, Ph.D.

This research aims to present a way to earn income for the government through the expansion of the property tax base. It basically collects tax from the asset owners that benefit from the increased value in the development of public infrastructure. There are two important objectives: First, the author wants to analyze the economic impact that occurs from the presence of the train station and other relating factors on the value of housing. Second, the author desires to apply the value capture method to create a tax model. The sample group is 511 residential buildings located within a radius of 2 km. along the road from the nearest MRT Blue Line station. The tools employed in this research are: (1) Hedonic Pricing Model, used to evaluate the relationships of various variables on the value of assets, and (2) Spatial Econometrics, used to solve spatial autocorrelation problem and increase the accuracy of estimates.

The study finds that only residential property located within a distance of 0-400 meters from the train station, is influenced through an increase in property price. The price is higher if a station is interchange station or junction connecting more than one line. Whilst, being easy to access public spaces and the strictness of enforcing Environmental Impact Assessment (EIA) Law result in a higher in real estate price as well. Finally, according to the tax model, if the government carries out progressive tax forms, the country's subsidies for infrastructure construction will be increased by approximately 34.63-173.15 million baht.



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Nanthawat Ouysinprasert

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# Chapter 1

# Introduction

## 1.1 Significance of the Research

Bangkok, the capital city of Thailand, is densely populated with about 10-million people and has an area of 1,568.737 square km. Chaophraya River is vital for the life of Bangkok citizens; it flows through the heart of the city and separates the urban core into two sub-areas: Thonburi and Phra-Nakorn, with 50 districts under its jurisdiction. The per capita GDP is US$ 15,192 per year[1]. Bangkok is; moreover, famous for being one of the best leisure destinations in Asia-Pacific as was awarded for two straight years by The Business Traveler Awards 2016-2017. Yet, it is still negatively regarded by tourists in many aspects, especially the chronic traffic congestion. In 2017, INRIX (2017) had rated Bangkok as the highest and 11$^{th}$ most traffic-congested city in Asia and the world, respectively. By average, drivers have to spend 64 hours a year in a traffic jam during peak hours.

**Figure 1.1** INRIX Traffic Scorecard Ranking by Cities in 2017

| RANK | CITY | COUNTRY | CONTINENT | PEAK HOURS SPENT IN CONGESTION | INRIX CONGESTION INDEX |
|---|---|---|---|---|---|
| 1 | Los Angeles; CA | USA | North America | 102 | 18.3 |
| 2 | Moscow | Russia | Europe | 91 | 20.1 |
| 3 | New York City; NY | USA | North America | 91 | 17.4 |
| 4 | Sao Paulo | Brazil | South America | 86 | 16.9 |
| 5 | San Francisco; CA | USA | North America | 79 | 13.7 |
| 6 | Bogota | Colombia | South America | 75 | 16.2 |
| 7 | London | UK | Europe | 74 | 14.1 |
| 8 | Atlanta; GA | USA | North America | 70 | 12.3 |
| 9 | Paris | France | Europe | 69 | 13.1 |
| 10 | Miami; FL | USA | North America | 64 | 11.8 |
| 11 | Bangkok | Thailand | Asia | 64 | 12.5 |
| 12 | Jakarta | Indonesia | Asia | 63 | 13.4 |
| 13 | Washington; DC | USA | North America | 63 | 10.8 |
| 14 | Boston; MA | USA | North America | 60 | 10.6 |
| 15 | Istanbul | Turkey | Europe | 59 | 12.2 |
| 16 | Mexico City | Mexico | South America | 58 | 12.4 |
| 17 | Chicago; IL | USA | North America | 57 | 10.3 |
| 18 | Medellin | Colombia | South America | 57 | 11.4 |
| 19 | Krasnodar | Russia | Europe | 57 | 12.4 |
| 20 | Seattle; WA | USA | North America | 55 | 9.6 |

**Source:** INRIX (2017)

[1] International $ using 2013 PPP conversion factor from World Bank

Many literature around the globe suggest that railway network could be a feasible solution to alleviate traffic congestion. Railway investment is expected to support a compact urban structure and urban sprawl and, therefore it serves the urban planning purpose (Debrezion, Pels, & Rietveld, 2007). Having developed a system such as metro or subway railway network can offer an alternative to the public much better than automobile, and thus can reduce congestions on the public road, and lessen the travelling times (Baum-Snow & Kahn, 2000) In Denver, Bhattacharjee and Goetz (2012) examined that LRT has succeeded in reducing the level of traffic along the adjacent highways and influence zone. Moreover, the railway network is an effective means of avoiding traffic pollution, and it also has accurate time schedule as well as carries a large number of ridership at the same time (Sun, Wang, & Li, 2016).

Investment over Mass Railway Transit (MRT) lines also generates more convenience to households settled nearby system. Those properties closed to metro stations have typically somewhat a tendency of price appreciation. The extended routes out of new Central Business District (CBD) will improve accessibility to the inner city from the suburb, increase new residential projects in suburb areas, and support transit-based policy, such as Transit Oriented Development (TOD) (Diao, Fan, & Sing, 2017; Xu, Zhang, & Aditjandra, 2016). This fact is also happening to the large city like Bangkok that there are a number of residential properties booming and specifically being built in kind of high-rise building like apartments or condominiums. These types of building have economic advantages in high populated density as well as accommodate more habitants per unit of land and decline the cost of municipal infrastructure. According to research from TarraBKK (2017)[2], ranked the top 5 most expensive locations in Bangkok for renting and buying residential properties. It also

[2] Retrieved from TarraBKK – Top-5 most expensive residential locations in Bangkok

pointed out that four of them were closed to the metro network within the radius of 1 kilometer. Similarly, Sukkumvit and Silom-Sathorn districts, the top 2 most expensive locations, have been crossed over by the interchange stations of two important lines, BTS Green Line and MRT Blue Line. Although, these locations are previously known as old CBD and luxurious zone; however, after having railway transit crossing by, the rental price has abruptly escalated by both land speculators and a great number of demand in those properties. Currently, the rental price in these locations costs between Baht 17,000 and 35,000 per month which is surprisingly about 34-70 times higher than the cheapest area of Bangkok at Klong Chanlong, Bang Khuntien district. Apart from the distance to the railway network, the rental property price is also fluctuated by the structural and neighborhood characteristics. Hence, the parking space and floor are as well as the proximity of the building to the necessary infrastructure could be key factors in dictating the rental property price.

Accessibility to public transport is such an important factor in urban development aside from social and economic factor. Although, in recent decades, Bangkok Metropolitan Administration (BMA) attempted to promote a more holistic system of transportation, i.e. improving the pedestrian network, expanding bicycle route, and rendering new metro railway project. All projects seemed to be great and well-planned by specialists, but the entire result did not go as expected. Many of them were delayed and indefinitely postponed especially the railway transit schemes.

Prior to the preliminary findings, the causes of unsustainability among those schemes are comprised of three dimensions. First, the coverage of railway network in Bangkok still remains low and does not completely decentralized from the urban core to periphery. Bangkok people living in the outskirts of the city cannot travel

from the office to their residence by using metro railway transit. However, it is definitely true because most of them have to align with other modes of transportation - like public bus or taxi. Since only 19 out of total 50 districts are covered by the urban rail transit, this brings the author deep concern on city imbalance between the rapid transformations of city structure and the construction delay of railway networks. Second, the mega-infrastructure projects, need a huge budget for construction. In reality, the national budget cannot be considered as the only source of funding since it is a potential risk for the government to encounter with the budget constraint on public resource and fiscal burden. Third, Bangkok citizens occasionally criticize that the railway networks are monopolized. Referring to the statistics analyzed by National Statistical Office (NSO) in 2013, which says Bangkok households have the monthly expenses approximately Baht 33,085.7. It is virtually not possible that the majority of people can afford to pay their whole budget for metro rail transit fare in addition to their saving or paying for the necessary items.

Therefore, the author seeks for measurement to resolve those problems and raise the standard of public transportation in Bangkok. As discussed above, one of the most crucial issues that need to be uplifted is pursuit of the budget for infrastructure investment. This will be the main topic to study in this literature. Currently, the Ministry of Finance has many tools to fundraise government projects, such as borrowing through the financial institution, or public-private partnership. But, it is not sufficient to fulfill those gigantic costs. To collect windfall tax from those property owners who benefit from the urban railway network is a new idea now using in many developed countries. This paper thus wants to examine the feasibility of using this tax through the tax simulation model. The author hopes that a windfall tax can augment government revenue and enhance Thailand’s fiscal sustainability.

## 1.2 Objectives

This paper aims to consider the economic framework so as to answer questions in the residential property market. It has two main objectives as follows:

- Firstly, it will evaluate the economic impact of an existing metro station proximity on the value of residential properties.
- Secondly, it will promote windfall tax rate simulation via using value capture method.

## 1.3 Expected Benefits

In the government perspective, to collect windfall tax from the property's owners is such a great way to raise local government revenue as well as broaden property's tax base. A major principle of this tax is that the government can earmark this revenue for specific purposes; in particular, Thailand transportation's scheme in the future. For example, it can subsidize for the construction expenses with less impact on the public debt as well as increase the accessibility of passenger by giving the special discount of ticket fare. Most importantly, this paper would benefit those who would like to pursue further research on this topic, especially for the government sector.



## 1.4 Scope of the Research

In terms of data scoping, it defines the 2-kilometer radius along the road distance from the closest MRT Blue Line station (Hua Lumphong - Taopoon) to the residential property as a benchmark for sampling data. This line will be the only circular line in Bangkok and have a high tendency to develop new Transit Oriented Developments (TOD). Within this research, it expectedly uses 511 samples of residential properties that have been occupied before April 2018

# Chapter 2

# Research Background, Literature Review, and Related Theory

## 2.1 Research Background

### 2.1.1 History of Bangkok's Railway Transit

The railway network in Bangkok has a century-long history since the reign of King Rama V, started with the tram railway serving the expansion of urban sprawl. After the construction of the Charoenkrung road, the first modern-type road in Thailand, had completed, along the two sides of this road had become a new business district in Bangkok. People used this road for transportation from suburb area to the terminal at The Grand Palace, which was then considered as a central of Bangkok. As time passed by, the road could not cope with an overflowing demand of users; since it had not initially been designed and constructed to withstand for the perpetual use, especially in the rainy season. This, therefore, was leading to the concession given to Mr. John Lofus and Mr. du Piesis de Rechetieu, two Danish investors, by the government of Siam in 1887 so as to establish the operation of the first tramway in Bangkok running from Thanon Tok to the city pillar (Bang Kho Laem Line). During the initial stage of the company, it used six horses for towing tram cabins. However, the company was eventually in heavy debt and transferred its concession to the other Danish company. In 1894, the tram system was modified to use electricity instead. After the World War I, the economy of Siam, which gradually improved, caused the increasing number of passengers and generated more profit to the company. Decades later, as the new modes of transportation– public bus, tricycle, and taxi- had emerged with wide availability, convenience and efficiency, leading to the decline of the tram. Moreover, the tram speed was relatively slow and occupied significantly the area of road space which caused traffic congestion. The tram operation in Bangkok was eventually all shut down in 1968.

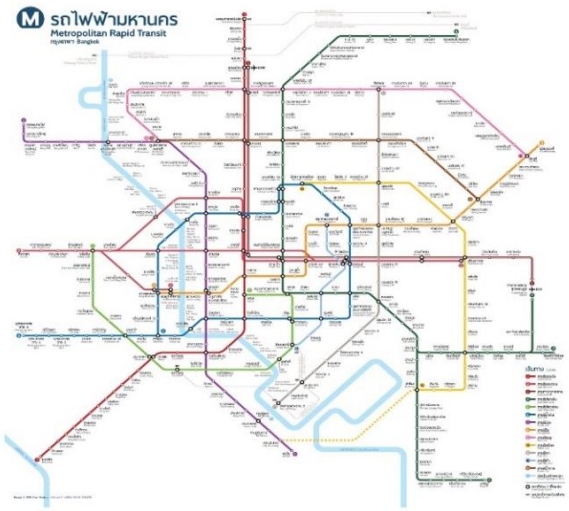
A new era of city railways transit, the MRT, LRT, and commuter, in Bangkok was resumed and proposed to the public again during the government led by Field Marshall Thanom Kittikachorn, the 10th prime minister of Thailand (1963-1973). He issued military-junta order No.290/1972 in order to establish the Expressway Authority of Thailand (EXAT), a state enterprise under supervision of the Ministry of Transportation. It was aimed to operate the expressway and metro system serving all Bangkok area and nearby provinces. During the decade from 1970 to 1980, most of the Thai governments had focused on the construction of expressway infrastructure in order to cope with excessive and severe traffic congestion along the line from a suburban area to the inner of the city. However, the railway transit project was a subject for discussion quite some time, but it did not reach any obvious decision to raise campaigns to promote the new railway transits. Negligence of investing in railway transit system was a result of its long time of construction and gigantic cost. In addition, the city railway transit was not then perceived by the public as practical and economical transportation. Until 1992, Hopewell Holdings, a private operator from Hong Kong, was granted a contract by the Thai government to build elevated highway and rail line running from Bangkok CBD to Don Mueang International Airport, namely Bangkok Elevated Road and Train System (BERTS), for approximately 80 billion baht. The construction was anticipatorily due to be in operation in 1999. Because of its delay in construction and various political scandal together with the Asian financial crisis in 1997, it was finally terminated by the cabinet in 1998.



Nevertheless, this incident had not diminished the hope of Bangkok citizen to have new modern railway transits because the other feeder systems at that time still proceeded as planned. The Bangkok Mass Transit System, known as BTS, was officially opened and operated in December 1999. It is the first metro railway running through the core area of Bangkok. The whole system consists of 2 lines, Silom Line

and Sukhumvit Line, with a total length of 25 kilometers. Soon later, MRT Blue Line and Purple Line opened for service in 2004 and 2016, respectively. These two lines are under the control of the Ministry of Transportation's state enterprise agency, MRTA. Nowadays, the railway transit in Bangkok and surrounding provinces comprise of several systems: BTS, MRT, and Airport Rail Link. All systems currently have 110.2 km. of track in total. The Bangkok railway transit network uses fully automated trains running on both underground and elevated guideway with 78 stations. Furthermore, it has been extrapolated that the whole project in M-MAP 1 will be accomplished by 2025-2029 (Figure 2.1 and Table 2.1). Currently, General Prayuth's government is moving forward to formulate M-MAP 2 as a policy guideline for an acting agency. Those new transit lines will connect to the previous lines in M-MAP 1[3], increase more integration with urban planning and provide more alternative choices for the ridership traveling to the destination with optimal benefits and minimized their traveling cost.

**Figure 2.1** Blueprint for Mass Rapid Transit Master Plan- Phase 1 (M-MAP 1)




**Source:** Home (2017)

[3] **Blueprint for Mass Rapid Transit Master Plan- Phase 1 (M-MAP 1)** is a masterplan of Bangkok railway network organized by transport and traffic policy plan office, Ministry of transportation. The status of M-MAP 1 projects has both in-operation i.e. MRT Purple Line- northern section, and under construction- i.e. BTS Pink Line and on-going in the cabinet process- i.e. MRT Orange line- Western section.

**Table 2.1** Blueprint for Mass Rapid Transit Master Plan- Phase 1 (M-MAP 1)

| | Line | Types | Distance (km.) | Entire Route |
|---|---|---|---|---|
| Primary Line | Dark Red Line | Commuter | 80.8 | Mahachai -Bang Sue -Rangsit - Ban Phachi |
| | Light Red Line | Commuter | 58.5 | Bang Sue - Salaya - Bang Bamru - Hua Mak |
| | Airport Rail Links | Airport Rail Link | 49.5 | Don Mueang - Bang Sue - Suvarnbhumi |
| | Dark Green Line (Silom Line) | MRT | 22.5 | Taling Chan - Bang Wa - National Stadium - Yotse |
| | Light Green Line (Sukkhumvit Line) | MRT | 66.5 | Bang Pu - Bearing - Mo Chit - Eastern Outer Ring |
| | Blue Line | MRT | 55 | Phutthmonthon Sai 4 - Tha Phra - Hua Lumphong -Tao Poon |
| | Purple Line | MRT | 42.8 | Klong Bangphai - Tao Poon - Kharu Nai |
| | Orange Line | MRT | 35.4 | Bang Khun Non - Thailand Cultural Centure - Suwinthawong |
| Feeder Line | Pink Line | LRT | 36 | Nonthaburi Civic Center - Min Buri |
| | Yellow Line | LRT | 30.4 | Lad Phrao - Samrong |
| | Grey Line | LRT | 26 | Watcharaphon - Rama 9 Bridge |
| | Brown Line | LRT | 21 | Nonthaburi Civic Center - Sammakorn |

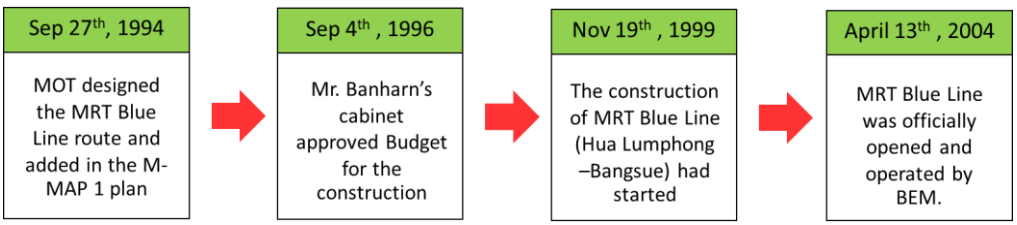
**Source**: Mass Rapid Transit Master Plan in Bangkok Metropolitan Region. (n.d.). In *Wikipedia*. Retrieved June 3, 2018, from https://en.wikipedia.org/wiki/Mass_Rapid_Transit _Master_Plan_in_Bangkok_Metropolitan_Region

### 2.1.2 MRT Blue Line, Bangkok

MRT Blue Line or officially called Chalerm Ratchamongkol- the celebration of royal auspicious- line is a rapid transit system serving the greater area of Bangkok metropolitan region. This line, initiated by the Mass Rapid Transit Authority of Thailand (MRTA), was completed in 2004. It now has a total length of 19 km. and 18 stations running from Hua Lumphong to Tao Poon Station in an anti-clockwise direction. The system uses 19 three-car metro trains of the Siemens modular types, each with its own motors and drawing power from a third rail. It can reach up to the speed of 80 km/h and carry approximately 40,000 passengers in each direction per hour. In Figure 2.2, it shows the 10-year timeline of MRT Blue Line since the Ministry of Transport launched the project in 1994 until it was officially opened in 2004.



**Figure 2.2** Bangkok MRT Blue Line's Timeline




**Source:** Accumulated by the author

At present, the whole line has seven interchange stations in total: with BTS at Silom, Sukhumvit, and Chatuchak Park Station; with Airport Rail Link (ARL) at Phetchaburi Station; with SRT at Hualumphong, Petchaburi and Bangsue Station; and with Purple Line at Taopoon Station. As mentioned earlier in M-MAP 1 blueprint, this line will be crossed with another four lines: Pink Line, Brown Line, Orange Line, and Yellow Line. For the operation contract, the government used PPP Net Cost concession to render the project, handed over to the Bangkok Express Way and Metro Public Company Limited (BEM), the operator which won the concession contract and operated for 25 years (2004– 2029). Later on, the government has prolonged the previous concession for 20 more years in order to allow the same operator to smoothly operate the future extension projects as a single system.

By mid-2019, this MRT Blue Line will be one of the most remarkable and significant lines in Bangkok since it will be ready to service as a circular line (See figure 2.3), covering major areas of Bangkok Metropolitan. This will bring a positive addition to enhance economic activities on the western side of Chaophraya River, where most is residential and green area. In addition, it will lessen the overcrowded passengers in BTS Silom Line as well as significantly improve the connectivity between two sides of Bangkok as divided by Chaophraya River. It is worth mentioning that the important stations on this MRT Blue Line's extension are; for example, Sanam Chai Station and Wat Mangkon Station. From Sanam Chai Station, passengers can easily travel to Bangkok's historical sites, such as The Grand Palace or Wat Pho,- by 10-minute walking. Whereas Wat Mangkon Station is located in the middle of Bangkok's China town. Furthermore, a representative from Bangkok Expressway and Metro Public Company Limited (BEM), Mr.Sombat Kitjalaksana, has predicted a great leap of the company that the average daily ridership will skyrocket by 52% from

360,000 in 2017 to more than 500,000 in 2020 after the extension sections' inauguration[4].

In total, the entire route are divided by its in-operation period into 5 phases:

- Phase 1: Hualumphong – Bangsue (Operation in 2004)
- Phase 2: Bangsue – Taopoon (Operation in 2016)
- Phase 3: Hualumphong – Laksong (In construction; scheduled to open in 2019)
- Phase 4: Taopoon – Thraphra (In construction; scheduled to open in 2020)
- Phase 5: Laksong – Phutthamonton Sai 4 (Planned; scheduled to open in 2021)

**Figure 2.3** Bangkok MRT Blue Line Extension Route


**Source:** Siemens (2015)

Owing to the blueprint of Mass Rapid Transit Master Plan- Phase 1 (M-MAP 1), there are multi-color of lines contained in, and, within a few years from now, they will be a tremendously complex network expanding throughout the Bangkok greater

[4] Retrieved information from: EfinanceThai [August 21st, 2017]. A brief press conference by BEM managing direction.

area. Moreover, after the extension parts of aforementioned lines are fully operated, they will all have greatly affected to land use decisions whether the land would be deployed for the purpose of households, firms, or the government sectors. For instance, the real estate firms may select nice places to settle in shops and offices; whereas, the households may also search for residential property closed to public transportation. Hence, it may not be wrong to say, railway transit is another factor that drives the economy more dynamic and competitive.

Additionally, the price of land will certainly be higher along with the economic growth in those proximities. By virtue of limitation in land supply, the land price is determined by only the demand of the market. As a matter of course, the fluctuation of the price is not only derived from the demand mechanism but also resulted from speculation by the investors. This speculative phenomenon is commonly found in popular and prime locations, e.g. closed to public infrastructures or CBD, since all investors have the intention to process and yield value-added from them. However, the benefit from development and price appreciation are not distributed to ordinary citizens as a whole but they only belong to the landlords, who are a minority group in the society. This leads to the main purpose of this research which is to estimate the windfall tax rate collected from the owners of the property for the public interest. Therefore, this study depicts residential properties settled in a radius of 2 km. from the closest in-service MRT Blue Line (Phase 1-2) as data samplings in this research.

**2.2 Literature Review**

Studies on the correlation between property value and node of transportation get lots of attention among economists around the globe. Even though the access to electric train, tram, or high-speed train actually soar the property price. But, the result is not the same as the case of shipping port and

airport that the property value has declined since they are directly affected by noise pollution (Duncan, 2011; Efthymiou & Antoniou, 2013). Therefore, the government should carefully consider the positive and negative impact of each public infrastructure program to price before issuing the policy, such as tax collection. However, prior to the finding, this literature will go over only the relationship between property value and MRT stations. Most authors have provided plentiful of empirical evidence that the stations have a positive impact to property value uplift and even higher than those located further away.

Among Thai literature have such limited empirical findings on this topic due to the structural problem. The current rail lines are not widespread throughout Bangkok as well as lack of rail connectivity with the upcountry provinces. Therefore, in practice, it is hard to illustrate the success of those investment and inconclusive to propose the policy suggestions. Still, there are many interesting pieces of literature analyzed on current in-operation rail transit; for example, Vichiensan, Malaitham, and Miyamoto (2011) examined that the property sale price along the BTS Sukhumvit Line increased about 25,000 baht for a kilometer nearer to the station. While Chalermpong (2007) found that the property sale price increased about $10 for every meter close to the BTS station. To introduce a more delicate result, a box-cox technique could be adopted to analyze attributes that determined the condominium price in Bangkok (Kulkolkarn & Laophairoj, 2012; Thamrongsrisook, 2011).

Nevertheless, a large number of previous scholars published during the past decades mostly took place in China. As it is commonly known that China can be accounted for the leader of cutting-edge rail technology and its rail-based systems fully run throughout the cities and between regions. The length of its total railways is approximately 121,000 km. which regarded as the world second longest railway

network after only the United States of America. To start with a case study from Wuhan, Xu et al. (2016) identified the positive effect of Wuhan MRT#2 on the commercial property values analyzed by Hedonic pricing method. They found that the 400 m. radius from the stations is much tighter than urban rail transit scope (700-1000 m). While in Tianjin- the world 6$^{th}$ most populous city, Sun et al. (2016) studied the change in the value of housing located within 1 km. from Subway Line 3 station. The result expressed two facts. First, the subway line, which had already been built, had a greater influence on the residence than the ones that were being planned. Second, the construction of the subway line had a greater impact on suburban zones than the city's downtown area. Later on, Zhang, Liu, Hang, Yao, and Shi (2016) constructed a panel data model to assess the influence of railway transit on residential prices in 35 Chinese cities between 2002 and 2013. The result demonstrated that every percent increase in rail transit mileage improved the price by 0.0233%.

Apart from China, other international literature are also developed economics technique to appraise the property value benefit from nearby railway transit. In Singapore, Diao et al. (2017) applied a DID approach to identify the effect of the new Circle Line (MRT Orange Line) on households. They found that the average housing price increased by 1.6% in the post-opening MRT and also found a significant increase for household living within a 400 meters distance. A recent study by Bazyl (2009) analyzed if there was a metro station within 1 km., the housing prices augmented by 15% and diminished by 7% in a green and industrial area, respectively. Moving to Haifa, Israel, Portnov, Odish, and Fleishman (2005) indicated the housing sales increase about 13% in the 100-meter train buffer zone and then gradually dropped by about 0.7% for each additional increase in the train line distance. Moreover, the duration of data collection may sometimes offer different

results. Yan, Delmelle, and Duncan (2012) explored how the proximity of LRT in Charlotte in North Carolina affected the single-family housing value. They had separated the time frame of data collection into 4 phases: pre-planning, planning, construction, and operation phase. The results expressed greater desirability to live closer to LRT as it became in operational. Whereas, some literature focused the value of capitalization on a specific time frame- announcing the construction. The average apartment price augmented about 3.3%- 4.4% due to having announced the construction of Santiago de Chile Metro (Line 4) in 2005 (Agostini & Palmucci, 2008). In addition, some early works suggest that heteroscedasticity problem should be also taken into account, e.g. Bohman and Nilsson (2016) proposed two-stage spatial quantile regression to capture variations of dwellings price to commuter train stations and provided more robust results.

Next, spatial econometric is the technique which lots of authors used for scrutinize the result of each model. Dorantes, Paez, and Vassallo (2011) reviewed the correlation between accessibility of Madrid Metro Line 12 and housing price; all of three models: OLS, Spatial Lag Model (SLM), and Spatial Error Model (SEM) yielded similar positive results. In Pheonix, Arizona, Seo, Golub, and Kuby (2014) combined the impact of highway and LRT on the residential value. They applied the Spatial Lag and Spatial Error Model using generalized Spatial Two Stage Least Square (GS2SLS). Coefficients for the distance to both highway and LRT; however, was not significant. Likewise, using land use data in Athens, Efthymiou and Antoniou (2013) found that Geographical Weighted Regression (GWR) gave the smallest AIC, meaning it fits data better than other spatial models (OLS, SEM, and SLM).

Finally, the previous literature about value capture tax collecting the benefits gain from the transport project is not easy to find. Overall of the study review, Xu et al. (2016)'s work was the only paper that concerns with that issue. They discovered

that the tax was only significant within a radius distance of 400 m from the commercial property to MRT#2 Line. The inner circle of 0 -100 m. had the highest price premium of 16.76%; while, between 100 m. and 400 m. had about 8% on average. Next, they simulated the captured value gain by setting land value tax of 0.5%, 1%, 5% on the commercial properties which generated revenue to government equal to 43.756, 87.511, and 437.557 million yuan, respectively.

To achieve the basic understanding of the influence of having railway transit to the property value, each literature should understand the land structure, basic infrastructure, and economy of those cities. This research will mainly take advantages from the property value appraisal by OLS regression analysis in order to generate tax simulation. Especially, it will add the spatial attributes in this paper. These variables will be deployed to make a more obvious conclusion and provide new guidance for using Thailand GIS database in the applied economics research.

**2.3 Theory and Concept for Study**

In this section, it will be a demonstration of the theories and concepts related to this study as well as exhibit details, advantages, and drawbacks of the followings.



2.3.1 Theory of Land Rents and Transport Costs

The overview of this model has the main objective to analyze the impact of transport on urban structure (Quinet & Vickerman, 2004). Nevertheless, this relationship is based on a particular case, the process of agglomeration. It can be found only in the constrained area which is assumed by this model as the Central Business District (CBD) and the rest area is surrounded by residential properties.

Apart from the residential housing area, each city has to allocate its land for the alternative use of commercial and agriculture. They denote $R_A$ for the price of

land over a unit of time and area. Distance from the center to where residents located can be represented by $x$. A cost of transport per unit of time, occupy space of the residential area, and the revenue that a landowner acquires from the tenant is $T(x)$, $S(x)$, and $R(x)$, respectively.

The price of land in the competitive market is given by

$$R(x) \geq R_A.$$

The problem of this model is to find the relationship between $T(x)$, $S(x)$, and $R(x)$. It is determined $N$ inhabitants and each one consumes a quantity of a composite good $Z$. All habitants must have the same convex utility function, $U(Z,S)$.

Moreover, the area of residence of each inhabitant is assumed to fix at

$$S = S_0$$

The city has a boundary area which can extend up to the maximum distance $X_M$ from the center. The density is constant and equal to $S_0$

$$\int_0^{X_M} \frac{2\pi}{S_0} x dx = N$$



Moving back to the utility function, the choice between different locations has been affected by both cost of transport, $T(x)$ and cost of housing, $SR(x)$. The best decision of each individual is to minimize both costs $(\partial C/\partial x)$ as given:

$$T'(x) + S_0 R'(x) = 0 \qquad \text{... (1)}$$

From equation (1), we can derive it in the form of $R'(x)$ :

$$R'(x) = -\frac{T'(x)}{S_0}$$

Then,

$$R(x) = -\frac{1}{S_0}T(x) + Constant \quad \text{... (2)}$$

The Constant variable is mainly determined by two factors- $R_A$: the price of land over a unit of time and area; and $T(x_M)/S_0$: cost of transport from a specific point to the boundary of the city per area of residence in each inhabitant

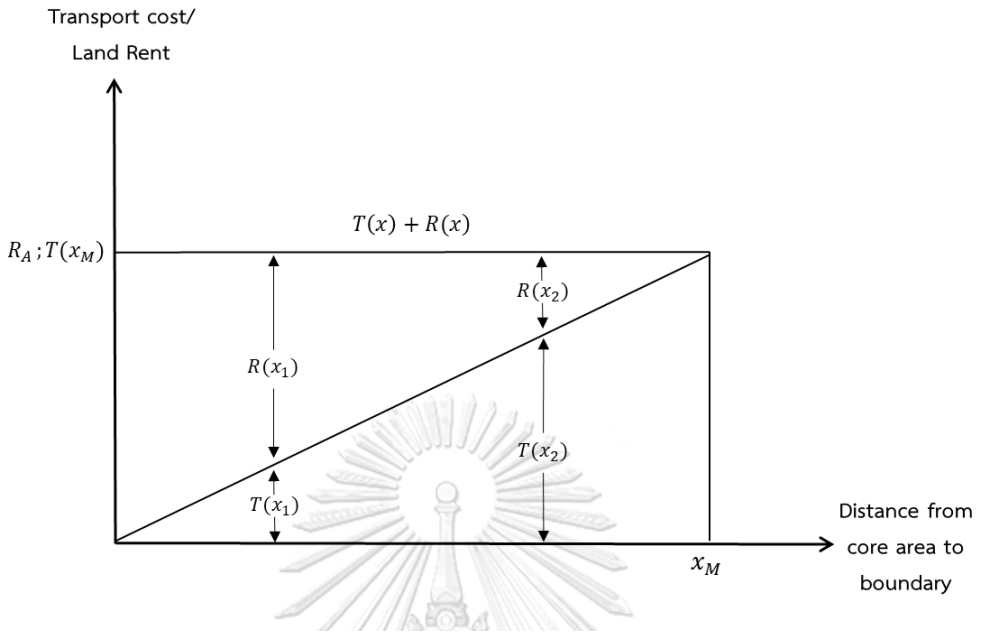
$$Constant = R_A + \frac{T(x_M)}{S_0} \quad \text{... (3)}$$

To substitute constant term from equation (3) into equation (2), it will yield the value of land lent at any location $x$

$$R(x) = -\frac{T(x)}{S} + R_A + \frac{T(x_M)}{S_0}$$

Please kindly note that although each individual has a different location; all locations face the same total costs, $T(x) + R(x)$. Still, transport costs and rent costs do not necessary to be equal among those individuals. The further the property settled outward from the center, the cheaper land rent will be, and vice versa. The land rent and distance from the core to the edge of city can be represented by $R_A$ and $x_M$

**Figure 2.4** Land Rents and the Cost of Transports




**Source:** Retrieved from "Principles of Transport Economics" by Quinet Emile & Vickerman Roger, 2004, Massachusetts: Edward Elgar Publishing.

In conclusion, to point out whether or not choosing each residential proximity all has to trade off high transport cost with low land rent, and vice versa. The equilibrium land rent will fall as the locations move outward from the core which at the boundary of the city will be equal $R_A$. For more clarification, if the dwelling location is chosen to close to the boundary of the city, it is clear that the land rent will cheaper than the core area. However, there is an opportunity cost of high transportation expense associated with it. The advantages of this model are that it explains the fact of selecting locations by mathematical model and makes the reader easily comprehend the analysis of land rent theory. Nevertheless, it cannot be adapted in real life situation because it has excluded the consideration of economic infrastructure– i.e. public school, public hospital, or city library- which also affects to the value of land rent as well. Additionally, this model is specifically

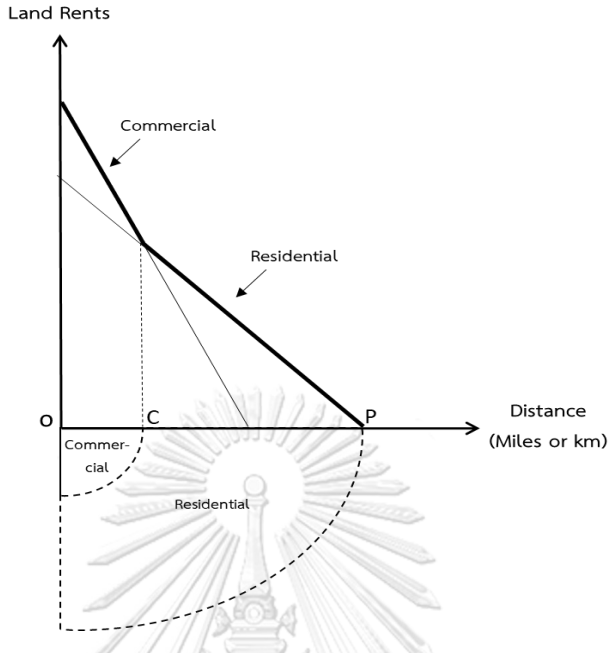
designed to use in monocentric city model only. It, hence, cannot be used to explain the polycentric city like Bangkok.

2.3.2 Von Thunen Model of Land Use

Basically, this model is adapted to explain the transport costs for carrying agricultural products that have been distinguished among each particular zone. It is thereafter linked to transport costs in urban areas. The analysis suggests that residential housing will be forced out from the core district by commercial firms. Additionally, the commercial zone, radius OC is surrounded by a residential zone, radius OP (Figure 2.5). As a result of the pattern of locational land use, the land values will decline from the center to periphery. Apart from the changes in the pattern of the city, they also have other related factors which could transform the urban structure through such as the size of population, technology, social and economic activities, government policy, and the growth of the urban area.

According to the assumption of Von Thunen, Harvey (2016) mainly explained in three significant facts: (i) the pattern of urban land use, (ii) the continued decline of land value from core area to the boundary, and (iii) the growth of urban area. Most cities normally have a similar pattern of separation between workplace and residential housing.

**Figure 2.5** Accessibility of Land Use




**Source:** Retrieved from "Urban Land Economics" by Jack Harvey, 1996, Basingstoke: Macmillan

In the urban area, it is possible to differentiate broad pattern of urban land use into a certain concentric zone, as follows:

A). The Central Business District (CBD)

CBD normally locates in the focal point of the city. The land uses in this area are utilized for many different purposes, i.e. shopping, recreation, commerce, business, and services. It is also where the transport center with bus and railway stations located so that it becomes the most accessible location for all people. Yet, the land space is limited due to the excessive number of population and economic growth. A continuously increasing in land value is the main cause of changes in CBD and include the following

- First, the compact structure of CBD led development to be high-rise buildings.

- Second, the exact borderline of CBD may not be easy to differentiate from industrial and residential zones. The land developers tend to take over the land from the prior residence and convert them into offices, services center, and commerce district.
- Third, the developers use the land area for a functional basis. For instance, entertainment area and retail shopping are separated from office buildings. However, we can still find school, central library, post office, as well as public administration within the CBD.

B). The Zone of Transition

This zone has varieties of land use among different groups of people from the lower-income group to the upper-income one. Subsidiary activities from commerce and retailing in the CBD, such as wholesale and warehouse, have been relocated to this zone. While other labor-intensive activities including employment agencies, printing, and clothing are moved out of CBD as well. The number of population and income growth within this zone is constant change, for example, warehouses are transformed into offices. In addition to old manufacturing, it is also turned into a modern one. There are lots of low-income and multi-family dwelling but it is rarely found the upper-class families live in this area.



C). The Suburban Zone

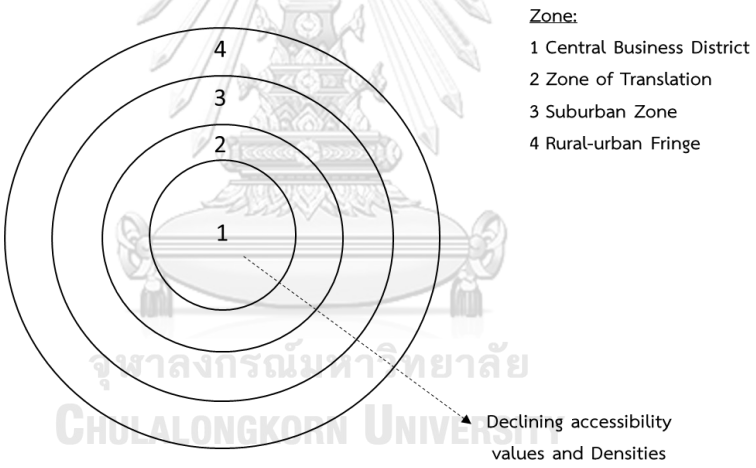
The commuter rail systems and highway road have been developed along the same time with this zone for many decades. It has been noticed that households in the suburban zone are clustered near road and rails services. Other facilities such as schools, hospitals, government offices, and religious places are sparsely distributed throughout the zone. In many suburban areas, there are currently having own unique activities which need a large space for construction and it is no longer efficient to

service in the city, such as universities and medical centers. Additionally, satellite commercial centers are becoming interested among office developments. In the near future, this zone is going to become more popular among all people since the land price is still cheap and adjacent to the transport links.

D) The Rural-Urban Fringe

The influence of the city land use has not reached to build anything in this area. People living in this area are still dependent on the suburban zone or towns closest to their residence. Some of them are a farmer; they still need to supply and carry their products to the cities.

**Figure 2.6** A Broad Pattern of Urban Land Use






**Source:** Retrieved from "Urban Land Economics" by Jack Harvey, 1996, Basingstoke: Macmillan

The Von Thunen model is quite similar to the theory of land rent and transport cost in terms of a slight decline in land rent from the core to the boundary. However, this model provides more empirical details in specific patterns of land use by dividing urban land use into 4 zones. Another extraordinary thing of this model is that it can find a cut-off point of the separation between residential and commercial area. Moving forward to this research, the idea of encircling zone can be adapted for creating windfall tax simulation. Nevertheless, it tries to avoid the unobserved

heterogeneity problem which might cause errors in the estimation. To control specific data samplings is the way to cope with this problem. While the effect of having MRT Blue Line might not have strong influences on the area which is far beyond than 2 km. radius from the residential properties. It is thus not necessary to concern over the context of land use in every zones except for the Central Business District (CBD).

2.3.3 A Tax on Land Value and A Tax on Land Rent

Normally, a tax on land can be imposed by charging from the total area of the land, land rents, or the value of land. This model also illustrates that the tax revenue levied on different tax bases, generates the same result (Kaipanen, 2017). In mathematical term, the relationship between land rents and land value can be shown as follows:

$$V = \frac{Y}{(1+r)} + \frac{Y}{(1+r)^2} + \frac{Y}{(1+r)^3} + \cdots + \frac{Y}{(1+r)^n} \qquad (1)$$

Where $Y$ = rental income received from land rent and $r$ = interest rate.

The above equation (1) tries to deliver a message that the value of land in equilibrium is equal to the present discounted value of the stream of future income. According to equation (1), it can be rearranged and written in the infinite series form:

$$V = \frac{Y}{r}$$

Though the government collects tax on land value, but the rent remains the same. The landowners cannot charge any tax on tenants. Then, the current land value changes to:

$$V = \frac{Y}{r + tv}$$

Where $tv$ = land value tax rate

The land value falls due to the present discounted value of the future stream of tax payments. In addition, the whole tax burden belongs to the owner of the land during the time that tax is levied. All future burdens of tax are capitalized into the current market price.

Finally, the relationship between tax on land value and tax on land rents can be written as below

$$Tr = \frac{Tv}{r + tv}$$

The landowner will receive annual revenue from land rent, $TrY$ while the tax on land value would be $Trv$. If both taxes generate the same amount of income, then $Trv$ would equal to $TrY$.

Land tax is one of the effective measurement for lowering incentive among investors who occupy land plots in nice locations and leave them as vacant lands. In particular, it can reduce tax evasion since people cannot hide the land oversea from the authority inspection like the income tax. Though this model, it seems to be practical, in reality, it also has a huge problematic. Since it still does not take consider the positive spillover effect of local real estate investment. Land value is not only capitalized by public infrastructure, but also affected by the private one– such as cinema, department store, or tutorial school. Therefore, it needs to be very cautious when using both taxes at the same time.



2.3.4 Hedonic Pricing Method (HPM) for Properties Value Appraisal

The origin of HPM model was commonly believed that it was firstly adopted by Rosen (1974); thereafter, Moulton (2001) claimed that it was initially published in the report of Price Statistics Review committee by Griliches (1961). A basic premise of HPM is used for estimating the value of the product's attributes; it is indeed widely playing an important role to evaluate the public infrastructure schemes including

property value. By collecting data from various types of properties, a multiple linear regression model is used to determine the correlation between a set of variables and the transaction price- e.g. physical characteristics and other external influencing factors that may add to or subtract from the building value.

The basic functions of HPM normally express in simple linear models. However, in fact, the sale price not only depends on the housing characteristics but also on the market tensions, bargaining power of the parties and search costs. Lisi (2012) adopted a standard matching framework a la Mortensen-Pissarides to explain the behavior of the housing market. The result showed that the selling price depends on the matching probabilities between seller and buyer which are intuitively non-linear form. Additionally, she also commented on the positive relationship of an increase in housing characteristics that it might be mitigated by market tightness. To determine accurate and consistent econometric models, hence, this research only discusses on non-linearity of HPM functions as given (Monson, 2009; Seo et al., 2014):

- HPM in Logarithm-Linear Form



Both residential price and other characteristic variables are taken in logarithm form. One attractive feature of this model, which makes its popular in applied work, is that the slope coefficients $\beta_k$ corresponds to the price elasticity of the characteristic variables. Specifically, the percentage change in explanatory variables results in $\beta_k$ percentage change in price. Then, it can be specified in the following form

$$\ln p_i = \beta_1 lnX_{1i} + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + \cdots + \beta_n lnX_{ni} + \varepsilon_i \qquad (1)$$

Where $p_i$ = residential price;

$X_{1i}, X_{2i}, X_{3i}, \ldots, X_{ni}$ = other characteristic variables

- HPM in Semi-logarithm Form

Similar to the previous one, the price of the residential property unit is still taken in logarithm form; while the other explanatory variables are in linear form.

$$\ln p_i = \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_n X_{ni} + \varepsilon_i \qquad (2)$$

Currently, Hedonic Pricing Model is one of the most common valuation techniques among economists. It is commonly used for estimating the value of ecosystem or environmental services as well as for property appraisal. The coefficients, attributing from the econometric equation, are the implicit prices and elasticities for each of characteristic. There are several advantages of this model such that the estimation value process is versatile because it can demonstrate the reveal preferences and accurate choices of the consumer. While the major drawback of HPM is multicollinearity problem since the data are collected from the same locations and the econometric equations normally contain many dummy variables. Moreover, the model still has not included some potential externalities factors which may distort the result of the estimation- such as inflation, interest rate, and tax policy.



2.3.5 Spatial Econometric Model

Spatial econometric can be defined as the collection of techniques that deal with peculiars caused by space or geography in the statistical analysis of regional science model (Anselin, 2013). To evaluate the property value, the location choices, which are such prominent indicators, make the spatial econometric much more complicated than ordinary OLS approach. Location decisions should; in particular, be considered not only on their own space but also attributes of neighboring positions in nearby space (Efthymiou & Antoniou, 2013). Thus, if the spatial research uses just the standard econometric technique, it would fail in presence of spatial

autocorrelation, which is commonly found in geographical data (Fujita, Krugman, & Venables, 2001).

A core idea of spatial autocorrelation is to tackle the methodological concern over the consideration of spatial data which often violates the assumption of spatial independence. Anyway, it does not differ from autocorrelation in time-series. The formal framework used for statistical analysis of spatial autocorrelation is a spatial stochastic process, or a collection of random price variable, $p$ indexed by location $i$

Since each random price variable is tagged by the location, spatial autocorrelation can be formally expressed by the moment condition,

$$cov[p_i, p_j] = E[p_i p_j] - E[p_i] \cdot E[p_j] \neq 0$$

Where $i$ and $j$: Individual observations (locations)

$p_i$ $(p_j)$: The value of a random price variable of interest at the location.

When the covariance is not equal to zero, it can be interpreted in terms of spatial interaction or spatial arrangement of the observations. Spatial econometric models need a $n \times n$ square symmetric matrix of neighbor position data points (or spatial weight matrix) to construct the covariance of the variables for measurement intensity of the relationship among pair of spatial units- e.g. distance, contiguity, and nearest neighbors. The procedure to deal with spatial independence can be justified in several ways such as: SAR, SEM, SDM, and SAC.



(1). Spatial Autoregressive Model (SAR)

An additional explanatory variable in the form of spatially lagged dependent variable $(Wp_i)$ can be expressed in the simple linear form as:

$$p_i = \rho W p_i + X\beta + \varepsilon_i$$

Where $\rho$: Spatial Autoregressive Coefficient

$\varepsilon_i$: A parameter for the error terms

$W$: Spatial weights matrix- a structure in term of what are neighbors for each location.

According to the simple form with holding the idea of time-series analysis, the spatial lag term $Wp_i$ is correlated with the disturbances. This can be seen in the reduced form:

$$p_i = (I - \rho W)^{-1} X\beta + (I - \rho W)^{-1} \varepsilon_i$$

In which each reverse can be expanded into infinite time-series, including both the explanatory variable and the error term of the locations (The spatial multiplier). As a result, the special lag term must be treated as an endogenous variable and proper estimation methods must be accounted for endogeneity due to simultaneity biased.

(2). Spatial Autoregressive Model in the Error term Model (SEM)

Spatial Autoregressive model can be transformed into a spatial autoregressive for the error term. $\varepsilon_i$. It is a special case of regression with the non-spherical error term, in which off- main diagonal elements of the covariance matrix express the spatial dependence in the disturbance process. It can be derived and illustrated as the follow



$$p_i = X\beta + \varepsilon_i$$

$$\varepsilon_i = \lambda W \varepsilon_i + \mu$$

Where $\lambda$: Spatial autoregressive coefficient of error.

(3). Spatial Durbin Model (SDM)

Spatial Durbin Model is resemble to spatial autoregressive model (SAR); however, it remarkably includes the autoregressive process in explanatory variables

(LeSage & Pace, 2009). For the advantages of this model, it has corrected the omitted variable biased and spatial heterogeneity problem. Ordinary SDM can be transformed into restricted form by rearranging the following equation.

$$p_i = \rho W p_i + (1 - \rho W) X\beta + \varepsilon_i$$

(4). Spatial Autocorrelation Model (SAC)

This model contains a spatial autoregressive process in both the dependent variable and error term. Hence, it can generate two spatial weight matrixes so as to calculate the exact result. The SAC model can be written into the restricted form:

$$p_i = \rho W_1 p_i + X\beta + \varepsilon_i \quad (1^*)$$

$$\varepsilon_i = \lambda W_2 \varepsilon_i + \mu \quad (2^*)$$

First, it will transform Eq. (2*) into Eq. (3*):

$$(I - \lambda W_2)\varepsilon_i = \mu$$

$$\varepsilon_i = (I - \lambda W_2)^{-1}\mu \quad (3^*)$$

Next, Eq. (3*) can be substituted in Eq. (1*):

$$p_i = \rho W_1 p_i + X\beta + (I - \lambda W_2)^{-1}\mu$$

$$(I - \rho W_1)p_i = X\beta + (I - \lambda W_2)^{-1}\mu$$

$$p_i = (I - \rho W_1)^{-1} X\beta + (I - \rho W_1)^{-1}(I - \lambda W_2)^{-1}\mu$$

As mentioned earlier, the positive addition of spatial econometric is to consider the correlation between points of observation, which regarded as the spatial effect. It thus makes the explanation more obvious than the estimation by traditional econometric. A remarkable advantage of the spatial econometric approach is that the location decisions are considered both on their own space and attributes of neighboring positions in nearby space. However, LeSage and Pace (2009) have pointed out the disadvantages of the model that the idea of spatial dependence and

spatial heterogeneity all violate the principle assumption of the econometric framework. This violation may cause biased coefficient estimates and easily make an incorrect inference.

# Chapter 3

# Research Methodology

## 3.1 Concept and Structure in the Study

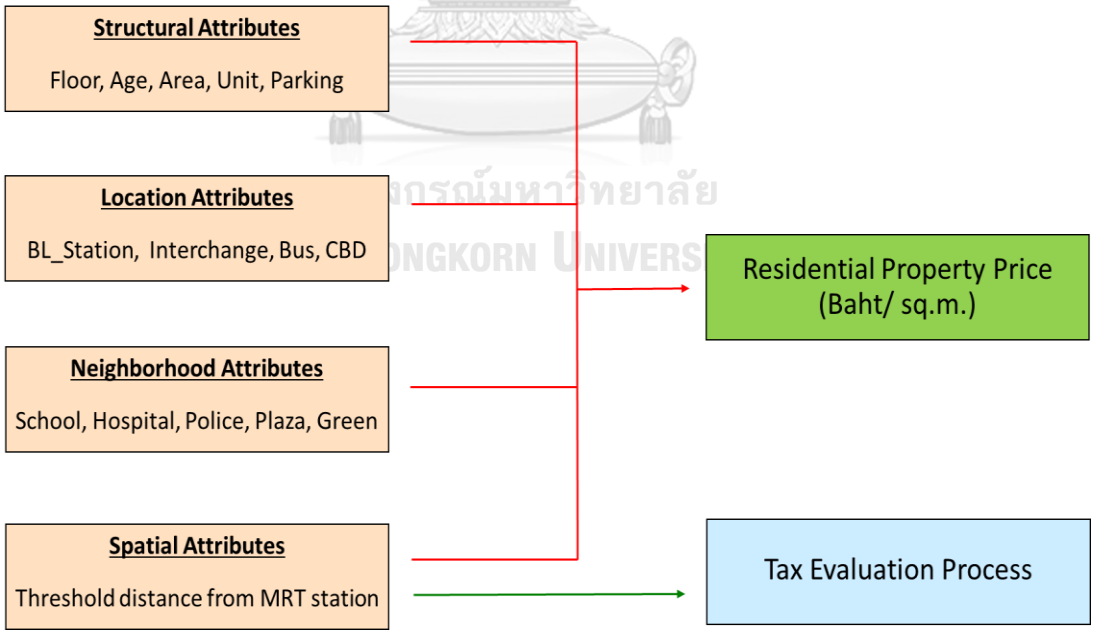
The core concept for the quantitative section is composed of two methods, the hedonic pricing model and the spatial econometric process (See in section 2.3.4 and 2.3.5). They are both used as a pathway to seek the accurate outcome and make policy suggestions. Firstly, the hedonic pricing method (HPM) is one of the most basic concepts normally adapted for appraisal value for the environment and natural resources. This technique has an interesting difference from other land value model because it has no limitation itself in using a variety type of variables. Within this research, it sends a message on how each independent variable, such as residential space in square meter or parking lot space, has influenced on property value. HPM is relatively not diffiicult to modify into various spatial regression forms and be applicable with large sampling like geographical data. Additionally, it is the most fitted model that clearly indicates a willingness to pay off individual landowner gaining from each consequence. Secondly, the spatial econometrics is employed to this research because it offers location preference more evidently than an ordinary model. There is concern over the relationship between selective location and its neighboring position within confined space. In addition, this method can cope with white noise or spatial autocorrelation problem, which arises from the development of the city, urban sprawl and land use pattern.

According to literature in the previous section, they mostly took advantages from the ordinary method and regular econometric process like Ordinary Least Square (OLS). On account of appraisal the property value, it does not need to use elaborate econometrics technique because it distorts the sampling and is difficult for

ordinary people to comprehend. Furthermore, it is widely believed among the economists that the most ordinary model is the most accurate model. Most of all, the major objective of this research is to evaluate tax simulation but not to suggest an advanced or new methodology for land appraisal. Hence, it is the reason why this research does not have much more concern with that point.

With regard to the conceptual framework diagram (Figure 3.1), this paper uses two theories aforementioned earlier to explain on two broad themes of question. In this context, it basically uses four types of attribute collecting from both database and self-collection. First, this paper wants to find the significant relationship between residential property relating components and its appraisal value (baht/square meter). Second, this paper utilizes the estimated coefficient of spatial attributes to generate an appropriate tax rate.

**Figure 3.1** Conceptual Framework Diagram




**Source:** Created by the author

Indeed, the author also adds qualitative sections in this research. Having a little hope that if the readers understand the budgeting problem, it might paint a

clear picture of why the government now needs to find new measurement to fundraise the revenue for the infrastructure projects. However, in 2018, the Thai government initiated the idea to levy a tax on the owners of real estate who receive increment value from public investment or namely 'windfall tax'. This event has inspired the author to seriously study the principles and possibilities of using this tool in Thailand. In the next chapter, the author thus accumulates global case studies employing the value capture method to earn a country's income. This measure is finally linked to what will be used to present the conclusion of this research.

## 3.2 Econometric Models and Statistical Correction

### 3.2.1 Econometric Models

For the econometric models, it uses five models which are both traditional and spatial econometric models. Each equation totally consists of 30 variables[5] which can be abbreviated in four groups of variable: location attribute $(LA)$, neighborhood attribute $(NA)$, structural attribute $(SA)$, and spatial attribute $(d_i)$. They are adapted to examine the correlations of each attribute to property value in logarithm form $(\ln p_i)$. The subscripts $i$ indexes the observation of residential property.



(1). Ordinary Least Square (OLS)

$$\ln p_i = \beta_1 LA_i + \beta_2 NA_i + \beta_3 SA_i + \sum_{i=1}^{10} \alpha_{ij} d_{ij} + \varepsilon_i$$

(2). Spatial Autoregressive Model (SAR)

$$\ln p_i = \rho W ln\, p_i + \beta_1 LA_i + \beta_2 NA_i + \beta_3 SA_i + \sum_{i=1}^{10} \alpha_{ij} d_{ij} + \varepsilon_i$$

[5] Note that a set of variable is listed in table 3.1

(3). Spatial Autoregressive Model in the Error term Model (SEM)

$$\ln p_i = \rho W ln\, p_i + \beta_1 LA_i + \beta_2 NA_i + \beta_3 SA_i + \sum_{i=1}^{10} \alpha_{ij} d_{ij} + \varepsilon_i$$

$$\varepsilon_i = \lambda W \varepsilon_i + \mu$$

(4). Spatial Error Durbin Model (SEDM)

$$\ln p_i = \rho W ln\, p_i + (1 - \rho W)[\, \beta_1 LA_i + \beta_2 NA_i + \beta_3 SA_i + \sum_{i=1}^{10} \alpha_{ij} d_{ij}] + \varepsilon_i$$

$$\varepsilon_i = \lambda W \varepsilon_i + \mu$$

(5). Spatial Durbin Model (SDM)

$$\ln p_i = \rho W ln\, p_i + (1 - \rho W)[\, \beta_1 LA_i + \beta_2 NA_i + \beta_3 SA_i + \sum_{i=1}^{10} \alpha_{ij} d_{ij}] + \varepsilon_i$$

(6). Spatial Autocorrelation Model (SAC)

$$\ln p_i = \rho W_1 ln\, p_i + \beta_1 LA_i + \beta_2 NA_i + \beta_3 SA_i + \sum_{i=1}^{10} \alpha_{ij} d_{ij} + \varepsilon_i$$

$$\varepsilon_i = \lambda W_2 \varepsilon_i + \mu$$



Where $W$ is a spatial weight matrix;

$\rho$ is a spatial lag coefficient, and

$\lambda$ is a coefficient on spatially correlated error.

3.2.2 Statistical Correction

- Multicollinearity Problem

After accumulating data from various sources, RStudio is utilized for analyzing correlations among variables in all of the above five equations. However, the author observes that it might have a sign of multicollinearity problem due to a number of

variables. Once when the model has high multicollinearity problem or high inter-associations among explanatory variables, it may not be precisely estimated coefficient and the standard error tends to be high. Due to the excessive width of the confidence interval of coefficients, it becomes less likely to reject the null hypothesis and produces an insignificant result. Therefore, it is such necessary to detect the degree of multicollinearity before analyzing the result.

To avoid the estimation errors, Variance Inflation Factor (VIF) is the measurement introduced to analyze the magnitude of multicollinearity by quantifying how much the variance inflated. If the VIF is over than 10, it suggests that the serious collinearity might occur in those variables. Then, the most problematic variables are crossed out of the estimation.

For the multiple regression model with $p$ predictors, $X_i, i = 1,2,3, \dots, p$, the VIF for the $i^{th}$ predictor variable can be expressed by

$$VIF_i = r^{ii} = \frac{1}{1 - R_i^2}, i = 1,2,3, \dots, p$$

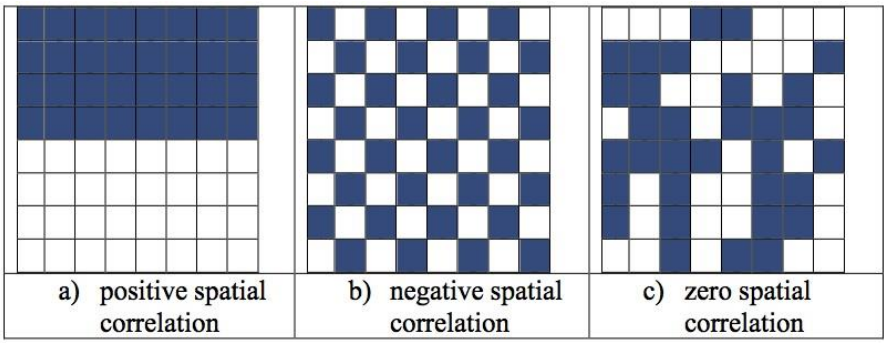
Where $R_i^2$ is the coefficient of determination of regression of $X_i$ on other explanatory variables (Murray, Nguyen, Lee, Remmenga, & Smith, 2012).



- Spatial Autocorrelation

Besides, when analyzing spatial data, it is very crucial to check for autocorrelation. If there is evidence of spatial autocorrelation, one of the underlying assumptions may be violated. Addressing spatial autocorrelation leads to more robust and replicable results. In Figure 3.2, the possible cases from the detection are positive, negative, or no spatial autocorrelation (Kirkegaard, 2015).

**Figure 3.2** Types of Spatial Autocorrelation




**Source:** Kirkegaard. (2015). In *the WINNOWNER.* Retrieved 28 February 2019, from https://thewinnower.com/papers/2847-some-methods-for-measuring-and-correcting-for-spatial-autocorrelation.

In this case, Moran's I test and Lagrange Multiplier (LM) test are brought to detect the spatial autocorrelation or spatial dependence (Anselin, 1999).

(1). Moran's I Test

Moran's I was initiated by Moran (1948) which is the two dimensional analogs of a test for univariate time series correlation. The theoretical framework is quite similar to Durbin's Watson test. It can be shown under null-hypothesis of no spatial autocorrelation. His notation statistic is given by,

$$I = \frac{N}{S_0} \cdot \frac{e'We}{e'e}$$



Where $e$: A vector of OLS residuals and

$S_0 = \sum_i \sum_j w_{ij}$= Sum weight for non-zero cross product

(2). Lagrange Multiplier Test (LM Test)

It is used for testing hypotheses about parameters in a likelihood framework. The hypothesis under test is expressed as one or more constraints on the values of parameters. The inference on spatial autoregressive coefficients may be based on Wald t-test or a likelihood ratio test. The LM tests allow for the distinction between a

spatial lag error and a spatial lag alternative. Both of them have an asymptotic $\chi^2(1)$ distribution.

(1). LM test against spatial error alternatives (Burridge, 1981)

$$LM_{err} = [\frac{e'We}{e'e/N}]^2/[tr(W^2 + W'W)]$$

(2). LM test against spatial lag alternatives (Anselin, 1988)

$$LM_{lag} = [\frac{e'Wy}{e'e/N}]^2/D]$$

Where $D = (Wx\beta)'(I - x(x'x)^{-1}x')(Wx\beta)/\sigma^2 + tr(W^2 + W'W)$

Next, the model selection process, it takes advantage of specification conditions to choose the best and most fitted econometric model. The model, which minimizes the value of the information loss, implies better goodness-of-fit. Basically, the Akaike Information Criterion (AIC) is commonly used for the estimation of relative quality among models in general scholars. It is an important index using for comparison the quality set of statistic model relative to each of other models (Akaike, 1974). This index provides just a means for model selection, but it will not tell the quality of the model. It can be defined as,

$$AIC = -2(\ln(likelihood)) + 2K$$

Let *K* be a number of estimate parameters and *likelihood* is the value of the likelihood. The most preferred fitted-model is the one offering minimum AIC value among other models.

### 3.3 Data Collection

In general, a good practice for the government in issuing policies is that they should not discriminate against certain group of people. To choose proper target group is thus one of the most significant procedure beyond any steps in the study. A list of residential properties separated by the provincial area is freely published on the website of Treasury Department, Ministry of Finance. In April 2018, there are 3,602 residential buildings in Bangkok Metropolitan Area. However, it is unfeasible that the entire buildings yield the benefits from the MRT Blue Line. The author therefore sets condition to eliminate irrelevant samples, and simulates as close to the truth as possible. Owing to the international literature, the maximum distance receiving influence from metro rail would not be greater than a kilometer. The results are different varied by cities; such as about 400 meter for MRT Orange Line in Singapore (Diao et al., 2017), 150-400 meter for MRT#2 in Wuhan, China (Xu et al., 2016), and 750 meter for Prague Metro in Czech Republic (Láznička, 2016). In this case study of Bangkok, the author supposes that the impact from metro rail might similarly display to these cities.



The rough conditions for data filtering are as follows: (1). those properties must be established within the distance of two kilometer by walk from the MRT Blue Line. To reflect the realistic walking path, the distance is calculated along the road from the main entrance of the property to the exit of nearest MRT station via using the Google Map; (2) all selected properties must meet the qualification of condominium[6], which has several individual home units, and share a common area managed by the owners through juristic person condominium; (3) the date of data collection process was on April 2018. Thus, all properties in this study must be

[6] Due to the unobserved heterogeneity problem which may bring about bias and inefficient estimation of parameters, the author accordingly limits types of residence only condominium by excluding house, home office and row house from the sampling pool.

inhabited before that period; and (4) the name and proximity of samplings must correspond with other data sources in the study. If any sample group does not qualify under one of these conditions, that property will be eliminated from the study.

At the end, this research uses a large sampling of 511 records of residential property located along the road with the proximity of 2-kilometer length to the closest MRT Blue Line Station. Location of these properties is collected in the form of GPS coordinates (latitude and longitude). Whereas a base map of Bangkok Metropolitan containing subdivisions, roads, water resources, and railways, it is taken from public domain database called 'GEOFABRIK[7]. As shown in Figure 3.3, it exhibits geographic coordinates of entire proximity of samplings and stations pinpointed on the Bangkok Metropolitan Map.

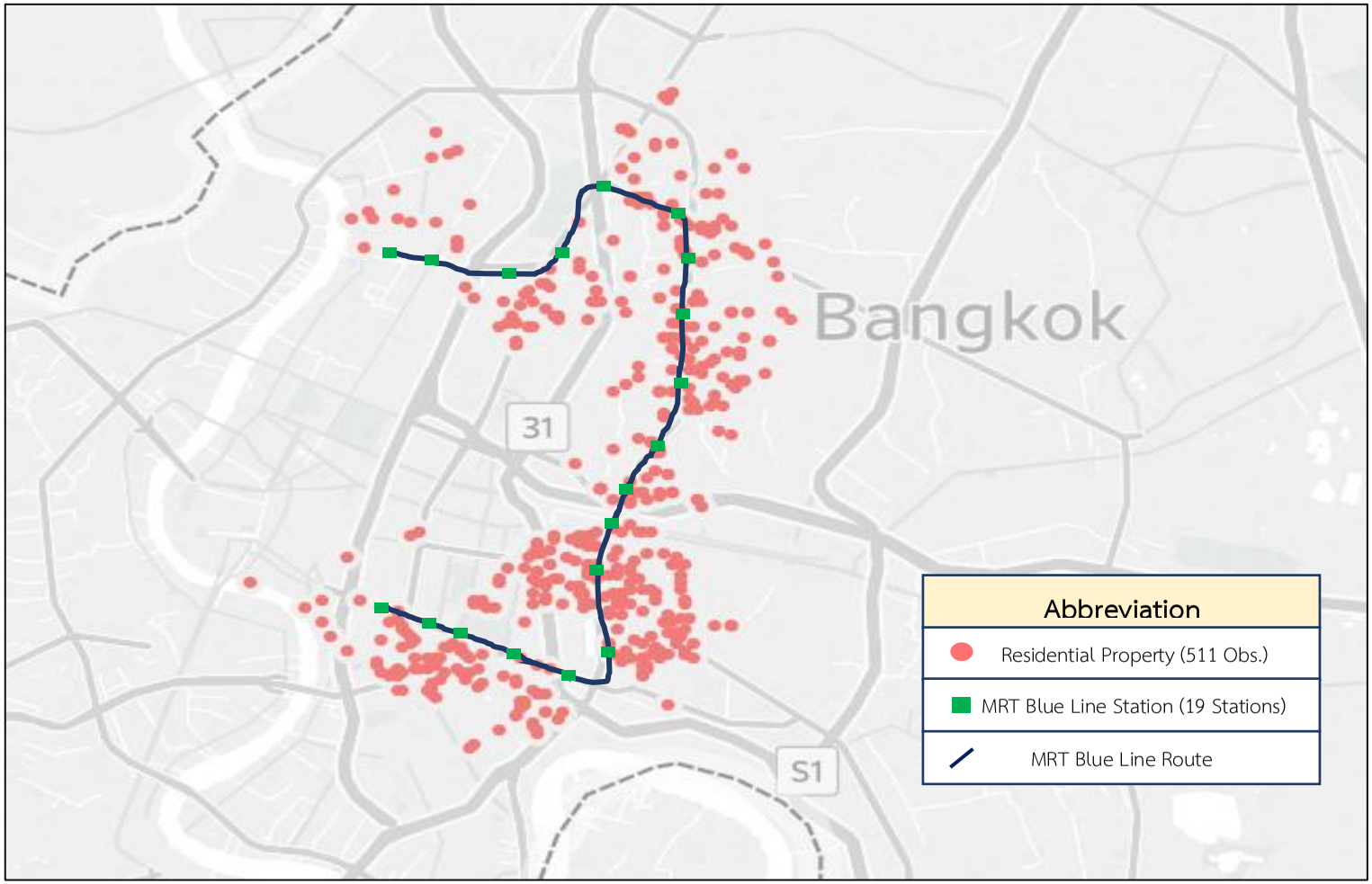
Additionally, to deal with geographic variables, the author has to control unexpected limitation especially the data gathered from a variety of sources. Making it easier to examine, all observations are saved in Shapefile[8] format, which is quite practical and easy to use. Also, they are geo-referenced to the centroid of each property using the WGS-84 coordinate system. Sometime, those variables may have the different coordinate values in different geographic coordinate system. They have thus adjusted all latitude and longitude value to measure in Degrees, Minutes, and Seconds (DMS) system.



[7] For further detail go to https://download.geofabrik.de/asia/thailand.html

[8] **Shapefile (.shp)** is a geospatial vector data format for geographic information system (GIS) software. It can spatially describe various feature: points, lines or polygons and then be stored as a shape comprising set of vector coordinate.

**Figure 3.3** A Map Representing the Geographic Coordinate of Data Samplings




Note: This map is generated in Tableau via using data from Google Map and Open Street Map

Next, there are two groups of the variable in the econometric estimation, dependent and explanatory variable. The former is residential property price; whereas, the latter is the components that may influence property prices as detailed below:

3.3.1 Dependent Variable – Residential Property Price (Baht/square m.)

A crucial concern for appraisal properties value is that the consideration and construction process on mega-infrastructure projects normally take quite a long time to complete. Therefore, the land price sometimes has been influenced and augmented beforehand by occupying from land investors (Yiu & Wong, 2005). Thus, the delays in the realization of the project are accounted for exogenous elements of the models (Quinet & Vickerman, 2004). To search for the actual property price is somewhat challenging since most data are confidential and limited for the authorities only. In order to seek for the solution, several works decided to use a proxy of real-time transaction price from housing search website instead (Deng, Ma, & Nelson, 2016; Efthymiou & Antoniou, 2013; Sun et al., 2016).

Fortunately, in March 2019, the Thai government effectively implements the new property tax called Land and Building Tax; this tax is the largest source of income for the local authorities, collected by themselves. This new property tax bill is to be firstly enforced in 2020 fiscal year. However, the property tax needs to be reassessed the tax base in order to be compatible with the economic conditions. Hence, the Treasury Department was directed by the Minister of Finance to estimate land and building price of every plots throughout the country. Even though this collection process has taken a lengthy period of time, but it has already been completed and all information is unveiled on the Treasury Department's webpage[9].



[9] For further detail go to- http://property.treasury.go.th/pvmwebsite/

Please kindly noted that appraisal price is arm-length price showing real value without any pressure of buying, or selling from the property market.

Based on the dependent variable, Palmquist (1982) and Maslianskaïa-Pautrel and Baumont (2016) claimed that housing is highly heterogeneous goods. To consider a specific type of property may yield better results; hence, this research specifically examines on a log of average residential property price of each project (Baht/square meter) only. Furthermore, it also crosses validity check with the real-time transaction and gathers additional information provided on property agent websites (eg. Kaidee.com; DDproperty; Interhome), including transaction price, preliminary location characteristics, and structural features.

3.3.2 Explanatory Variable

Moving on the variables on the right-hand side of each econometric equation, it also needs to find proper factors for the valuation process and inspect the relationship to the property price. Musa (2016) added that the value of houses depends on the degree at which the accommodation provides each customer satisfaction, i.e. taste or preference. Meanwhile, Thomas (2018) mentioned that investment infrastructure is a major influence on the land with housing development. Infrastructure services like water, sewerage roads, and other utilities highly require for development. Likewise, investment in public transit system could enhance labor mobility and facilitate the development of new land as well.



To construct the hedonic pricing model, it basically consists of four categories of variable which can impinge on price: structural attribute, location attribute, neighborhood attribute, and spatial attribute. To avoid omitted variable bias, this paper, therefore, adds variables as much as possible. (See a description of variable used in Table 3.1)

Firstly, structural attributes are mainly assembled from the 2017 Official Property Appraisal Database on the Treasury Department website. A data set contains basic qualification of each property such as size, age, floor, and location. Besides, appraised value has elucidated differently by floor level and types of uses, e.g. residential area, commercial area or even balcony space. Although there are some variables that are not completely disclosed in detail on the website, the author directly collects the remaining data from property agent websites and legal entity of those buildings by making the query thru telephone call or sending e-mail instead.

Thanks to Environment and Quality Promotion Act, the central government hopes that capitalists and landowners should be responsible for an environmental issue. Each project owner has to be endorsed from the authorized agent so as to produce an EIA report. Indeed, some project may take up to 8-12 months to complete the whole process. As a consequence, many property owners avoid financial burden from consulting fee and time cost by seeking legislation loophole[10]. There are at least 181 samples exempted for EIA report submission. More specifically, 80 percent of them is 8-story building which is the optimal condition for being excluded from this act. This paper thus introduces dummy variable "EIA" so as to capture effect from the operation and unobserved cost which is the addition to the property price.

Secondly, location attributes are considered based on the distance of the property to the location sites that mostly make use of geographic information system (GIS) technique to measure them. For the coordinates of the various location, they are primarily employed vector features in Shapefile format from Bangkok GIS

[10] By virtue of section 46(3) of the Environment and Quality Promotion Act, any residential property with higher than 23 meters, or taller than 8 floors, or more than 10,000 square meter of gross area have to submit EIA report to be approved by Ministry of National Resource and Environment. For the non-capturing group, they do not have to declare EIA report to the authority.

database[11]. Then, the author utilizes distance matrix command in QGIS[12]. to calculate the shortest Euclidean distance between two positions along the road.

Owing to "BL_Station", it is the most important variable in this estimation since its coefficient can be exploited to answer the main objective. Considering the facilities provided on MRT station, they also have several associated factors making differences among stations — such as having Metro Mall[13], free public toilet, interchange platform, and direct underground link from concourse level to the nearby building.

Likewise, the highest agglomeration zone in the city as such a central business district (CBD) is a great location indicator to demonstrate how far from the city center to property settled surround. The closer to CBD is, the higher in value of land gradient is (Johnson & Ragas, 1987; Morales, Flacke, & Zevenbergen, 2017; Moran, 1948). Although CBDs in particular towns are dissimilar in terms of spatial shape, they still have resembled identity in land use pattern. Commercial, office, and retail space are clustered in high-density area with efficient transportation networks. Increase in transit ridership and pedestrian trips can, in turn, support the nodal type of commercial development (Gihring, 2009). In this literature, it preliminary exemplifies from three commercial zones in Bangkok Metropolitan as "CBD" dummy variables: Silom_CBD, Sukkhumvit_CBD, and Rama IX_CBD.



Thirdly, neighborhood attributes resemble the second category in terms of data analysis, yet it ponders over utilities around each property instead. Most

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[11] For further detail go to - http://www.bangkokgis.com/

[12] **QGIS** is an open source geographic information system (GIS) licensed under the GNU General Public License. It supports numerous vector, raster, and database formats and functionalities.

[13] **Metro mall** is the transit retail shops settled inside 11 MRT Blue Line Stations. All of them are now operated by Bangkok Metro Network Limited (BMN), a subsidiary company of BEM, since 2005. They have several stores of leading restaurant and minimart- e.g. Starbuck Coffee, Dunkin, Café Amazon, A&W Grab to Go, and Lawson. Moreover, they also provide free Wi-Fi, co-working space, and public toilet to all clients.

variables are basic infrastructure services and amenities in the city, such as police station, public hospital, park, public school, and university. Some places are community centers like temple, church, or market. Overall data are still accumulated in Shapefile format from Bangkok GIS. Interestingly, there are plenty of economic literature that particularly study on the effect of public infrastructure to the property price; for instance, urban parks yield a positive significant to the property price since they can substitute private park and offer various types of services to the urban population like aesthetic, environment function, and enjoyment (Brander & Koetse, 2011; Dehring & Dunse, 2006). Furthermore, Lee (2015) examined the residential land price in Seoul, South Korea. Having new school in district augmented land price by 13 percentage points on average and about 26 percentage points for locating in a better school district.

Lastly, spatial attributes are all spatial dummy variables generating specifically for tax estimation. A set of spatial variable elaborates on location variable namely "BL_station" or the distance between residential property proximity along with the road network to the closest MRT station. Basically, they separate into ten zones with threshold distances of 0-100 m., 101- 200 m., 201- 300 m., 301- 400 m., 401- 500 m., 501– 600 m., 601-700 m., 701- 800 m., 801 -900 m., and 901- 1000 m. Afterward, this research takes advantage from spatial coefficients or implicit price to assess tax base. Basically, the tax evaluation employs a progressive tax rate method which is a fitting option to distinguish enhanced value from having MRT station settled nearby. To reduce the tax burden on the least people who can afford to pay, it should not be equally punished on landowner by a fixed tax rate. For instance, there are two houses located within a radius distance of 100 m. and 1000 m. from the train station, but these houses have equivalent value. In reality, to collect betterment tax, they should not deserve to pay at the same amount. The first house's owner has more

comfortable from walking distance to the train station and higher in the property price. Thus, the first owner should be punished by tax more than the second one.

**Table 3.1** Descriptive of Variable Used

| Type | Variables | Definition |
|---|---|---|
| Dependent Variable | price | Residential property value appraisal (baht per squared meter) |
| Strutural Attribute | floor | Numbers of floor in a multi-storey building |
| | age | Age of the the project (base year: 2018) |
| | area | Total area (squared meter) |
| | unit | Numbers of housing unit in the project |
| | parking | Having parking space at least 50% of the whole units (1 if yes; 0 if no) |
| | fitness | Having fitness room in the project (1 if yes; 0 if no) |
| | shop | Having minimart or shop in the project (1 if yes; 0 if no) |
| | wifi | Having free wifi providing in the public area (1 if yes; 0 if no) |
| | eia | Having to submit EIA Report Following by the Law (1 if yes; 0 if no) |
| Location Attribute | bl_station | Distance to the closest MRT Blue Line station (meter) |
| | interchange | The closest BL_station can interchange to other route in M-MAP1 project. (1 if yes; 0 if no) |
| | metromall | Having Metro Mall inside the closest BL_station (1 if yes; 0 if no) |
| | bus_d | Distance to the closest bus stop station (meter) |
| | rama9_cbd_d | Distance to the Rama9 CBD (meter) |
| | sukk_cbd_d | Distance to the Sukkhumvit CBD (meter) |
| Neighborhood Attribute | school | Distance to the closest public school (meter) |
| | university | Distance to the closest university (meter) |
| | police | Distance to the closest police station (meter) |
| | ground | Distance to the closest public space, e.g. park or playground (meter) |
| | plaza | Distance to the closest plaza, mall, or store (meter) |
| | market | Distance to the closest fresh market (meter) |
| | temple | Distance to the closest buddhist temple (meter) |
| | church | Distance to the closest church (meter) |
| | hospital | Distance to the closest public hospital (meter) |
| | gas | Distance to the closest gas station (meter) |
| | post | Distance to the closest post office (meter) |
| Spatial Attribute | d1 | Property located within 0-100 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d2 | Property located within 100-200 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d3 | Property located within 200-300 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d4 | Property located within 300-400 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d5 | Property located within 400-500 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d6 | Property located within 500-600 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d7 | Property located within 600-800 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d8 | Property located within 800-1000 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d9 | Property located within 1000-1300 m buffer zone, by road distance (1 if yes; 0 if no) |
| | d10 | Property located within 1300-1500 m buffer zone, by road distance (1 if yes; 0 if no) |

**Source:** Created by the author

# Chapter 4

## Results

The first section of this chapter will provide the latest facts of Thailand's mega-investment projects in transportation. These schemes are to purposely reduce chronic traffic congestion, enhance the performance of the logistic sector, enlarge import- export channel for the local investor, and lead economic growth. Nevertheless, an inside lag of the government sector, especially the delay of project approval, is a major obstacle to launch them. Not only do the authorities consume their time on red tape processes- such as documentation, excessive regulation, or project bidding, but also they have to allocate limited government budget efficiently. Hence, it could not be wrong to say that the government has to set the budget based on priority of the projects. Of course, the final result might inversely send high opportunity cost to the citizen who should benefit from the least important ones.

Therefore, the alternative solution to this issue is that the government may need to take advantage of other fiscal tools to reduce the burden of reliance on the national budget. Issuing government bond, infrastructure investment fund, and Public-Private Partnership (PPP) agreement are the tools that Thai government can now facilitate the fundraising for public investment; but they are still not enough to fulfill excessive cost. In particular, General Prayuth's Cabinet has expectedly planned to use expenditure on transportation projects approximately two trillion baht in the 2019 fiscal year (Prachachat, 2019). It is virtually not possible that the government budget will be able to finance entire gigantic burdens. Additionally, each tool has its advantages and weaknesses that will be discussed in section 4.1.

One proposal is a reformation of tax collection. It has expectedly to fill a gap of budget deficit. But the main question is "What tax should we use to subsidize those infrastructure projects?" Taxing on land and property has been widely supported by tax economists, because, it is practical and non-distortionary. Landlords cannot move their land offshore to avoid tax inspection like income or other forms of mobile asset. The property tax is easily predictable than consumption and income tax which quite fluctuate on consumer behavior. In addition, the gross revenue will finally advocate itself in the form of community benefits.

At present, property taxes in Thailand are all levied by local government, at the municipal level. They can be separated into three types: (1). Building and Land Tax, (2). Local Maintenance Tax, and (3). Signboard Tax. The first two types are going to be substituted by Land and Building Tax and be effective in 2020. Nevertheless, it is a compelling story that at present, the income collected by the local government accounts for only 10 percent of the annual gross revenue. The rest of revenue are all subsidized by the central government. This issue is such of a great concern about decentralization to the local government, and should be urgently considered. Therefore, it is about time that the local government should seek a new local tax tool so as to help them rely on their own and reduce their dependence on the central budget. Also, Stein (2016) proposed comment upon tax in his article "The Weed: The Land Value Tax, Explained (Out Loud)[14]" published on Vox.

"*One reason our tax system sucks is that it tends to punish exactly the kind of behavior we should be trying to reward… Income taxes discourage workers from earning money. Investment taxes discourage innovation and savings. Property taxes discourage homeowners from building cool stuff.* (Stein, 2016)"

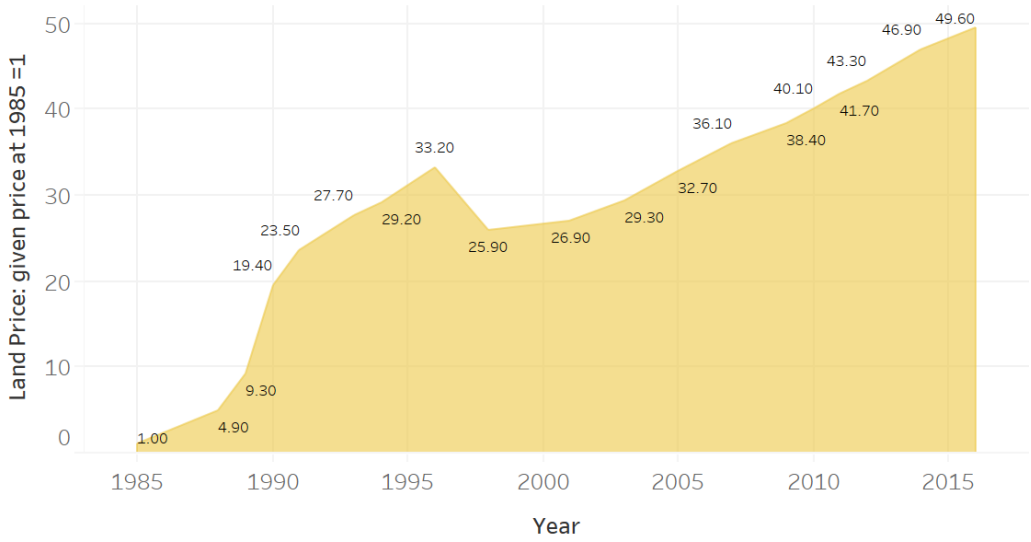
[14] For further detail go to- https://www.vox.com/2016/5/2/11533936/the-weeds-land-value-tax-explained

Thanks to the limitation of property tax, taxing on increment value of the property becomes a new option for tax collection. Thus, property value in the catchment area of public infrastructure project is one target among the policymakers. The owners of real estate get the benefit of those schemes more than the transport fare charging on them. The consumer surplus is capitalized into the value of property around transport network, in the form of a 'transport premium' (Housing & Committee, 2018). Transport projects generate numerous development specifically in the catchment area, which in turn rewards windfall gain to owners. A technique called 'value capture method' is employed to capture such gains from the investment in the form of increment value to the owners. It will be explored in detail in section 4.2. Many developed countries now adopt value capture method to use at the local government level, such as London (UK), Hong Kong and Beijing (China), or Atlanta, Kansas City, and San Francisco (USA).

Thailand has drastic changes in land use and city structure from both public and private investment throughout many decades. The 'price on land' is a popular indicator that can be used to measure the change in land use, especially in the crowded city, like Bangkok (See the fluctuation of land price changes in Figure 4.1). At this moment, there is still a debate about the inequality in access and possession of the real estate. It mostly falls into the hand of rich people and capitalist, who are the minority group of the country. In Thailand, it still has no serious law enforcement to capture increment value from the property owner and equally distribute benefits to all people. Though the government launched a draft proposal[15] of a windfall tax on land and property for the first time in 2018; but it is disappointing that the law has been postponed for an indefinite period.

[15] To be discussed in detail go to Appendix A

**Figure 4.1** Land Price Changes in the Bangkok Metropolitan between 1985- 2016




**Source:** Agency for Real Estate Affairs (2017)

To sum up, the structure of this chapter is mainly separated into four sections. In the first two sections are the qualitative part. Whilst, the latter two sections are the quantitative part. In section 4.1, it will discuss Thailand's source of funding on state infrastructure projects. Then, section 4.2 will highlight on an alternative funding approach through the value capture method. Section 4.3 will introduce descriptive statistics. Lastly, section 4.4 will propose empirical analysis and results.



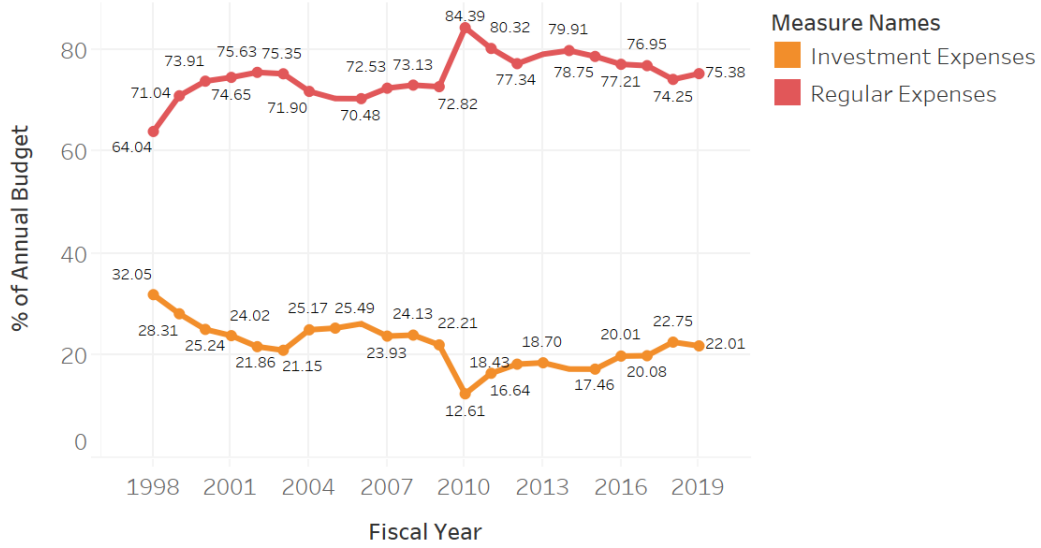
## 4.1 Sources of Funding for Thailand's State Infrastructure Projects

Public expenditure or expenses incurred by public authorities has been closely monitored by not only opposition parties but also taxpayers. Each year the government drafts and presents a budget plan to the house of representative. By the constitutional mechanism, it freely opens for the cabinet members to proclaim the detail of projects implemented in the next fiscal year. Correspondingly, it allows opposition parties to make inquiries and vote for the project approval or suspension.

The government can only use the budget after the annual Budget Expenditure Act has been approved.

Basically, Thailand's public expenditure can be classified into two main categories, according to the production efficiency criterion. Firstly, productive expenditures are government investment spending that generates more capital stocks and promote economic growth in the long run. These schemes are, for instance, road construction, human capital investment, or healthcare expenditure. Secondly, the unproductive expenditures are mostly the spending for government consumption, e.g. military spending or civil servant salary. Although there are other expenses included in the annual budgeting, like an expense for loan repayment and expense for treasury reserves compensation, but in fact, they account for only 0.6-4% of entire expense annually[16].

**Figure 4.2** Thailand's Regular and Investment Expenses by Fiscal Year




**Source:** The Comptroller General's Department (2019)

[16] The monthly statistic of Thailand's regular and investment expenses is gathered by the Comptroller General Department, Ministry of Finance. It has freely published on the following website, http://www.fpo.go.th/main/Statistic-Database.aspx.

Thanks to Thailand's budget statistics between 1998 and 2019, it clearly shows that government uses a large portion of expenditure on regular (unproductive) expenses approximately three times than investment (productive) expenses (see Figure 4.2). In 2019, the ratio of regular and investment expense is in the range of 75.38 to 22.01. However, to subsidize the mega-infrastructure investment projects through national budgeting might not be only a single option. Since these projects spend a large amount of expense and time cost during the construction. Likewise, there are concerns about high opportunity cost for other necessary spending and possible burden in the form of committed budget for the following years. As a result, Thailand's fiscal system paves the way to raise funds through various channels for the investment on infrastructure schemes as illustrated below:

4.1.1 Public Debt or Government Borrowing

Public debt is the government owned debt created by issuing securities, government bonds, or treasury bills. The law allows the government to create debt so as to drive the country, especially when it implements fiscal deficit policies- a country having expenditure more than revenue. According to the law, the government must borrow budget to compensate that deficit in a single fiscal year. Likewise, the debt management process has to abide by the Financial and Fiscal Discipline Act (B.E.2561) and the Debt Management Act (B.E.2548). The government can incur debt from both domestic (e.g. commercial bank, national bank, or domestic people) and international source of funding (e.g. IMF, AIIB, or JICA). Within the 2019 fiscal year, there are a number of infrastructure projects to run up debts as outlined by the debt management plan, such as five projects in dual railway track program, and HSR North- Eastern Line (Section 1: Bangkok- Nakorn Ratchasima).

Thanks to the debt management plan, the government must comply with decree 49 in the Financial and Fiscal Discipline Act relating to due diligence and

worthiness, debt repayment ability, and fiscal sustainability. In addition, the loan operation must follow public debt management framework. From Table 4.1, it shows that all targets in the 2019 fiscal year still achieve under maximum limit. While the public debt to GDP is the most significant indicator showing the nation's fiscal status whether it is in good condition or not. As stated by the Public Debt Management Office's announcement[17], the estimated public debt to GDP between 2019 and 2028 will proportionally fluctuate between 40.9- 46% which is still below the maximum level at 60% (See Figure 4.3). Though the public debt forecast will continue to decline in the next 5 -10 years, the amount of debt may be higher in one day if the government uses loan channel without fiscal discipline. The excessive in the public debt may lead to a perception of higher default risk, capital outflows, and a devaluation of the exchange rate (Schönerwald & Vernengo, 2007).

**Table 4.1** Thailand's Public Debt Management Framework in the 2019 Fiscal Year

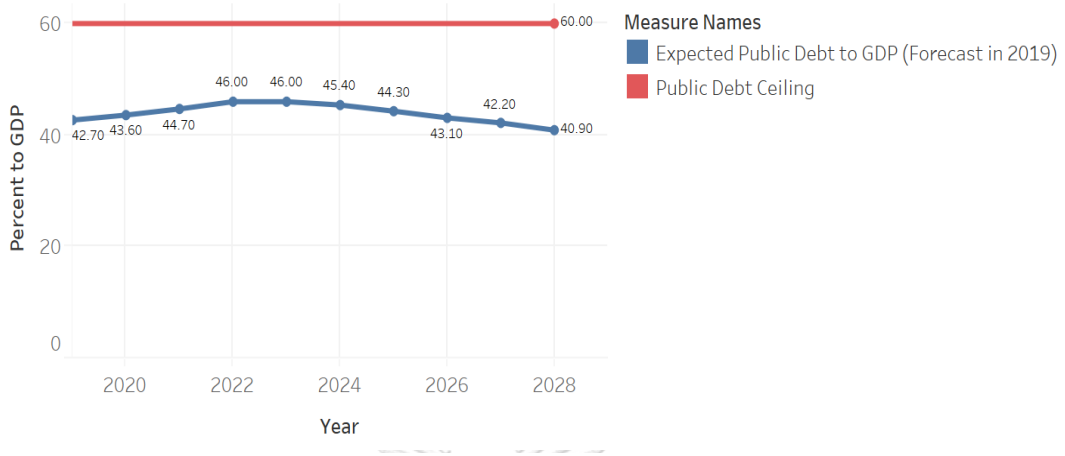
| Public Debt Management Framework (%) | Maximum Limit | Actual operation |
|---|---|---|
| Public Debt to GDP | 60.00 | 42.70 |
| Government Debt to Revenue projection | 35.00 | 23.50 |
| Foreign Public Debt to Gross Public Debt | 10.00 | 3.20 |
| Foreign Public Debt to Income from Export Goods and Services | 5.00 | 0.22 |

**Source:** Public Debt Management Office (2018)



[17] Public Debt Management Office (2019). The Announcement from the Ministry of Finance- Public Debt Management Plan in 2019 Fiscal Year. Retrieved 28th December 2018 from http://www.pdmo.go.th/pdmomedia/documents/2018/Oct/แผนการบริหารหนี้สาธารณะ%202562.pdf.

**Figure 4.3** Estimated Public Debt to GDP between the Fiscal Year 2019 -2028




**Source:** Public Debt Management Office (2018)

4.1.2 Public-Private Partnership (PPP, 3P)

Public-Private Partnership is a long-term collaboration between the government sector and the private sector to provide new assets and services to the public. The private party is responsible for the construction, operation, and risk-taking, instead of the state. Whereas, the government entity rewards the private company by granting concessions on the public project in return. In general, the private company, which wins the bidding and receives the PPP concessions from the government, would request the lowest construction subsidies as well as provide the highest benefits to the state. This mechanism would efficiently reduce government budget, enhance return on investment (ROI), and reduce delay in project completion.

PPP can be formulated into two types: PPP- Net Cost and PPP- Gross Cost. The former is that the private sector has the right to collect revenue and then allocate part of the compensation to the government according to the agreement. The private sector must take risk of all operating results. For the latter one, the government has the right to collect the whole revenue instead. However, the state will remunerate compensation for private companies based on operating cost with a fixed payment.

**Table 4.2** Strategic Plan for Private Investment in State Enterprises: Opt-In Business

| Project | Project Owner | In Responsibility of | Estimated Total Investment Value (Million Baht) | Estimated Private Investment Value (Million Baht) |
|---|---|---|---|---|
| **(1). Inner- City Public Transportation System** | | | | |
| 1.1 BTS Light Green Line (Mochit- Saphan Mai- Kukot) | Mass Rapid Transit Authority (MRTA) | Ministry of Transport | 38,011.57 | N/A |
| 1.2 MRT Orange Line: Eastern Section (Thailand Cultural Center- Min Buri- Suvintawong) | Mass Rapid Transit Authority (MRTA) | Ministry of Transport | 113,790.40 | 20,709.00 |
| 1.3 MRT Orange Line: Western Section (Taling Chan- Thailand Cultural Center) | Mass Rapid Transit Authority (MRTA) | Ministry of Transport | 124,249.00 | 12,738.00 |
| 1.4 MRT Purple Line (Taopoon Ratchburana) | Mass Rapid Transit Authority (MRTA) | Ministry of Transport | 128,235.00 | 26,486.00 |
| 1.5 Mass Transit Project in Phuket | Mass Rapid Transit Authority (MRTA) | Ministry of Transport | 39,406.06 | N/A |
| 1.6 LRT Green Line: Double Tract (Bang Na- Suwarnabhumi Airport) | Bangkok Metropolitan Administration (BMA) | Ministry of Interior | 27,892.00 | 8,616.00 |
| 1.7 LRT Grey Line: Single Tract (Watcharapon- Thong Lo & Phra Khanong- Phra Ram 3) | Bangkok Metropolitan Administration (BMA) | Ministry of Interior | 45,925.00 | 20,220.00 |
| **(2). Inner- City Road Development Business with Toll Collection** | | | | |
| 2.1 Expressway Project in Phuket (Kratu - Patong) | Expressway Authority of Thailand (EXAT) | Ministry of Transport | 12,804.95 | 10,211.75 |
| **(3). Public Port Development for Shipping** | | | | |
| 3.1 Laem Chabang Port Development Project (3rd Stage) | Port Authority of Thailand | Ministry of Transport | 141,357.60 | 87,004.47 |
| 3.2 Pak Bara Port Project, Satun | Marine Department | Ministry of Transport | 20,525.52 | 2,707.62 |
| 3.3 Songkla Deep Sea Port Project, Songkla (2rd Stage) | Marine Department | Ministry of Transport | 16,550.00 | 2,472.31 |
| 3.4 The 2nd Public Port Mangement Project | Industrial Estate Authority of Thailand | Ministry of Industry | 3,000.00 | N/A |
| 3.5 Public Port Mangement Project for Loading Liquid Product | Industrial Estate Authority of Thailand | Ministry of Industry | 13,000.00 | N/A |
| 3.6 Map Ta Phut Industrial Port Development Project (3rd Stage) | Industrial Estate Authority of Thailand | Ministry of Industry | 10,000.00 | N/A |
| **(4). High Speed Rail Development Business** | | | | |
| 4.1 High- Speed Rail Project, Bangkok- Rayong Line | State Railway of Thailand (SRT) | Ministry of Transport | 152,448.00 | 150,355.00 |
| 4.2 High- Speed Rail Project, Bangkok- Hua Hin Line | State Railway of Thailand (SRT) | Ministry of Transport | 100,125.07 | 95,276.97 |

**Source:** State Enterprise Policy Office, Ministry of Finance (2017)

In the case of Thailand, both types of the PPP have been continuously applied to many transport infrastructure projects as shown in the Five-year Strategic Plan for Private Investment in State Enterprises Between 2017 and 2022. In particular, all multi-colored railway transit projects are categorized as “Opt-In” business or business which is suitable for private participation in investment (See Table 4.2).

In addition, PPP concept has been adopted and put into practice with mega infrastructure projects around the globe. The implementations of foreign PPP are found in many fields such as transportation, resources and environment, public health, education, and sports. For example, the London underground train projects namely ‘Deep Tube Lines- Jubilee and Northern & Piccadilly Lines’, were 30- year PPP project for maintenance and improvement of various railway, track, and civil structure (Butcher, 2012). In the 2008 Beijing Olympic Bird’s Nest Stadium project enabled the private companies to participate in the design, investment, construction, maintenance, and repair process. Meanwhile, the private sector could earn income from rental fees, advertising fees, admission fees, and others throughout the concession period of 32 years (Chinyere, 2013). Moving to the public health program, the Royal North Shore Hospital Program had implemented PPP to facilitate health service in the local community along with improving the parking space. However, the private sector had to promote non-clinical support in return (ClaytonUTZ, 2008). Furthermore, PPP played an important role in supporting educational support in Singapore. In 2007, it subsidized expenses for construction school buildings and other accommodation of ITE College West (Gunawansa, 2010).

4.1.3 Infrastructure Fund (IFF)

Comparing with other mechanisms, infrastructure funds are considered as fundraising way through a mutual fund. It directly raises the fund from ordinary investors so as to develop in the public infrastructure program with high investment

value. An advantage of IFF is that government is still the owner of public infrastructure without having burden to the public debt level. Also, the infrastructure fund can enlarge the role of the capital market. In addition, private firms can bring their infrastructure businesses to raise funds and develop other infrastructure with reasonable costs. There are a number of projects invested through this fund such as telecommunications, airport, electricity, water supply, transport, and alternative energy. Each fund has a clear objective to invest in any business.

Meanwhile, the investors can be anyone who has enough fund and does not want to face risk and high fluctuation. A core principle of infrastructure fund is that the issuers will bring unit trust to be listed in the stock market and open for trading, like ordinary common stock. The investors will receive return in the form of dividend and capital gain from the difference between offering value and market value. Furthermore, the revenue from these funds may sometimes be exempted from income tax for a period of time.

Infrastructure funds in Thailand are, for instance, Digital Infrastructure Fund (DIF), BTS Rail Mass Transit Growth Infrastructure Fund (BTSGIF), and TRUE Growth Infrastructure Fund (TRUEGIF). While Thailand Infrastructure Funds (TFFIF) is one of the latest infrastructure fund directly supported by the government sector. This fund was firstly opened for the public funding around the end of 2018. Its main objective is to reduce the fiscal burden on investment structures and provide an opportunity for people to invest in a high-quality asset. In the first stage, TFFIF will invest in the right to receive 45 percent of gross income from toll revenue of Burapha Withi and Chalong Rat Expressway for 30 years. Expressway Authority of Thailand (EXAT) is in charge of these two projects. Later, the government will bring this revenue to provide capital for two new expressway projects: (1). Rama III- Dao Khanong- Western

Outer Ring Expressways, and (2). N2 and Eastern E-W Corridor of the Third Stage Expressways.

**4.2 Value Capture Method: A New Funding Approach**

At present, to uplift the quality of public transport infrastructure generates several benefits to various stakeholders, such as transport users, business sectors, or property owners. A rapid investment in public infrastructure can expeditiously facilitate labor mobility and development of new land around transport infrastructure (Thomas, 2018). At the same time, it creates economic value for the cities, including increases the value of properties and land adjacent to new infrastructure, augments labor market participation, and enhances the economies of agglomeration. Notwithstanding overwhelming costs of building, operating, and maintaining the system, the responsible government agencies currently struggle to finance all of those burdens themselves. It is thus such a challenging issue to seek for the new mechanism.

A Value Capture Method hence accounts for a cutting-edge funding vehicle designed to provide revenue for financing new capital improvements. (Chapman, 2017; Gihring, 2009). The core principle of this measurement is to capture the unearned increment values generated by public policy changes or public infrastructure investments: such as roads, electricity, sewerage, and other utilities, and then contribute the revenue to finance these systems. It, of course, does not consider only for new development but includes existing properties as well. Meanwhile, Salon and Shewmake (2011) added that seeking a new funding method is essential to move forward transportation projects especially in times of economic crisis. Though there is a little concern over the potential for revenue stream volatility since funding income may sometimes lower than expected cost.

Thanks to the literature written by Thomas (2018), there are several ways that the policymakers can capture economic value from transport infrastructure. Basically, it can be categorized in mainly two types: (1). Tax or Fee-based Policy Instruments, and (2). Development- Based Policy Instruments, as shown in Table 4.3

**Table 4.3** Transport-Related Value Capture Mechanism

| Tax, Levy or Fee-Based Policy | Development-Based Policy |
|---|---|
| • **Tax Increment Financing (TIF):** It is a tool that administrative divisions use to spur development in economically distressed and undeveloped area. A funding for TIF projects is collected from increment value or local property tax. | • **Direct Public or Joint Development:** Government owns land and collaborates the private party to create a return on land development. Later, those revenue from the improvement will contribute to subsidize future transport infrastructure. |
| • **Land Value Tax/ Location Benefit Levy:** It is a tax that tied to total (rental) value of land or improvements on each piece of property located in the vicinity of a public transport amenity. However, this tax is separately collected from a regular property tax. | • **Sale or Lease of Land:** Government sells or leases to developers land of which the value has increased relative to the initial public acquisition price public investment and/or regulatory change, in return for an upfront payment, leasehold charge or annual land rent payment. |
| • **Income or Payroll Tax:** Income earners in the region served by the new transport infrastructure pay an extra increment of income or payroll tax, which is allocated to the public transport body. | • **Sale or Lease of Development Rights or Air Rights:** Similar to sale or lease of land, but in this instance is air or development rights that are sold or leased. The added value from the new public transport system is capitalized into leased price. |
| • **Special Assessment Districts (SADs):** SADs are additional tax on properties within a defined geographic area in order to fund improvement projects. They are subject to a vote by the group who will pay the tax. | • **Land Readjustment:** Landowners pool their land and contribute a portion of their land for sale to raise funds and partially defray public infrastructure development costs that will have raised the value of the land in question. |

| | |
|---|---|
| • **Sales Tax Levy:**<br>Increases to existing or new retail sales taxes are allocated to the funding of a particular transport project. | • **Transport Company Business Diversification:**<br>The transport agency diversifies its business model to generate additional revenue to fund the core business of transport provision. |
| • **Transport-focused Development Fees:**<br>Developers in the vicinity of a new public transport investment pay extra fees for new building projects. | • **Rezoning:** Changes in land-use policy to allow commercial or residential development. This will often include enabling higher- density housing development. |
| • **User Fees:**<br>The users of public transport services will pay an additional fee for the new or/and improved services. | • **Leasing of Commercial Space:**<br>The public transport agency retains ownership of the commercial space in and around the stations and leases it out to businesses at market prices. |

**Source:** Thomas (2018)

Having seen that many metropolitans have brought the value capture method to finance large infrastructure projects, and later proved success in land use planning and development. This research obtains promising lesson and remarkable accomplishment from three powerful nations: China, United Kingdom, and India.

- Hong Kong, China

In case of the MRTC or Hong Kong Transit Railway Corporation, it operates the metro system itself without government subsidy and also gains highly profitable for over 15 years from 1998. Most of its revenue is derived from private developers in the real estate sale and from managing MRTC's properties. Only around 20% of profit comes from the transport operation. Likewise, to develop property along the railway indirectly benefits MRTC by attracting new residents and labor forces to settle housing nearby the station (Verougstraete & Zeng, 2014).

- London, United Kingdom

Similarly, the Crossrail-2, a new metro project in London expected to complete in 2018-19, is aimed to increase the use of rail transit and lessen congestion in the city. About of a third of total expected cost (£14.8 billion) is generated by Greater London Authority (GLA) through the business rate supplement (BRS), a fiscal method based on Land Value Capture Finance. Medda (2012) analyzed the effectiveness of BRS and found that it would yield a greater financial return on investment over the duration of project.

- Hyderabad, India

According to World Bank article authored by Suzuki, Murakami, Hong, and Tamayose (2015), it says that Hyderabad has paralyzed with traffic congestion and also faced with a notorious toxic gas problem for a long time. A plan to construct metro was thus initiated to discuss among the authorities. However, it later discovered that the railway was expected to cost 14,132 crore (US$ 2.2 billion) which was too expensive and pressed huge demand on the public purse. A public-private partnership using mechanisms to capture land value became an ingenious solution to its cash shortfall. L&T Metro Rail (Hyderabad) Limited received the right of way along the rail corridor as well as the land around metro stations from the government. It makes about half of its revenue from developing and renting real estate. The rising in land prices associates with the new infrastructure as a way to finance the investment.

**4.3 Descriptive statistics**

In Table 4.4, it summarizes the descriptive statistics for econometric estimation. There are thirty variables with statistical implications: number of observations, mean, standard deviation, and maximum-minimum value. The total number of samples is 511 buildings which are all residential buildings. Among these variables, price (baht/ square meter) is the dependent variable, while the remaining variables are compulsory ones. Starting with property price, it is a good indicator for measuring the quality, type, and location of those properties. The price is ranged from the cheapest (10,000) to the most luxurious one (319,354) with extremely high in standard deviations at 37,017.38.

Moving to structural characteristics, the average value of age (=12.88) means that most of the buildings were constructed around 2005-2006. It can say that most buildings were built after the operating of MRT Blue Line in 2004. Having the high quality of mass transportation plays an important role in urban development including changing the pattern of land use within the city enormously. Those barren lands are continuously occupied by land developers. Owing to other amenities in the building, nearly all samples have parking space for dwellers. Whilst, the number of properties having fitness, free wifi and shop accounts for 85.2%, 40.2%, and 26.2% of entire samples, respectively. About 33.8% of entire samplings that are taller than eight floors has to submit the EIA report.



Indeed, the location attributes, bl_station_d is such a crucial variable to constitute a set of distant dummy variables (d1-d10) as well as construct windfall tax calculation. The average distance between the property coordinate to the closest MRT station is 974.4 meter. Only 38% and 54% of all properties are settled to closest MRT Blue Line station that can interchange to other MRT Line and has metro mall inside the station, respectively. The average distance from the closest bus stop to

property sites is fairly about 273 meters. While, the average distance to either two Bangkok International airport, Don Mueang Airport and Suvarnabhumi Airport, is 17.345 kilometers. The location sites of the airport need a large space for building runway and airport terminal so that they are normally located far away from the center of the city. This study is concerned with the effect of the central business district (CBD) to the property price as well. Silom CBD and Sukhumvit CBD represent the old CBD, whereas, Rama 9 CBD is the new CBD. The distance from property sites to CBD is between 3,666 and 5,281 meters.

Adding neighborhood factors can elevate result explanation and demonstrate that the samples are diverse. For instance, the average distance from the place of education to property coordinate is 738 m. for school and 1,429 m. for university. Other public spaces and religious places all have the average distance by walking more than 500 m from the buildings. The average distance from the properties to the gas station and post office are 491.2 and 711.3 m., respectively.

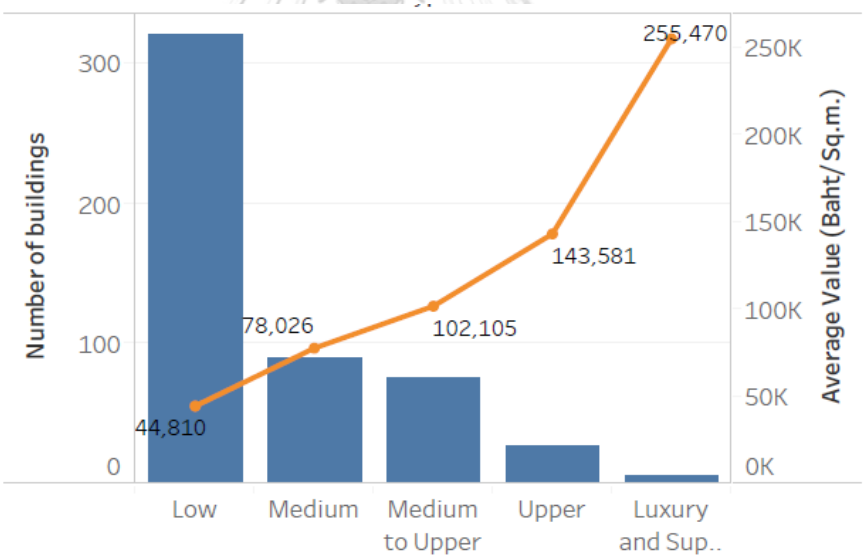
**Table 4.4** Descriptive Statistics

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | N | Mean | SD | Min | Max |
| Price | 511 | 66117.47 | 37017.38 | 10000 | 319354.6 |
| Age | 511 | 12.88 | 8.723 | 1 | 37 |
| Floor | 511 | 18.11 | 12.36 | 3 | 66 |
| Aream2 | 349 | 4,087 | 5,071 | 194 | 49,354 |
| Unit | 498 | 210.3 | 239.1 | 7 | 2,024 |
| Parking | 511 | 0.990 | 0.0981 | 0 | 1 |
| Fitness | 511 | 0.852 | 0.355 | 0 | 1 |
| Shop | 511 | 0.262 | 0.440 | 0 | 1 |
| Wifi | 511 | 0.402 | 0.491 | 0 | 1 |
| Eia | 511 | 0.338 | 0.473 | 0 | 1 |
| Bl_station_d | 511 | 974.4 | 584.6 | 20.06 | 1,996.46 |
| Interchange | 511 | 0.379 | 0.486 | 0 | 1 |
| Metromall | 511 | 0.540 | 0.499 | 0 | 1 |
| Bus_d | 511 | 273.7 | 245.8 | 0 | 1,416 |
| Airport_d | 511 | 17,345 | 3,233 | 9,958 | 22,933 |
| Rama9_cbd_d | 511 | 3,666 | 1,711 | 136.3 | 7,964 |
| Sukk_cbd_d | 511 | 3,975 | 2,635 | 115.1 | 10,420 |
| Silom_cbd_d | 511 | 5,281 | 3,075 | 241.4 | 12,089 |
| School | 511 | 738.3 | 388.6 | 46.87 | 1,946 |
| University | 511 | 1,429 | 605.7 | 153.9 | 3,422 |
| Police | 511 | 1,193 | 549.4 | 36.23 | 2,324 |
| Ground | 511 | 559.6 | 300.7 | 32.45 | 1,398 |
| Plaza | 511 | 884.7 | 573.2 | 14.37 | 2,802 |
| Market | 511 | 1,250 | 604.1 | 35.16 | 2,434 |
| Temple | 511 | 1,180 | 531.0 | 116.3 | 2,765 |
| Church | 511 | 625.5 | 358.1 | 31.26 | 2,362 |
| Mosque | 511 | 1,834 | 1,269 | 99.85 | 6,698 |
| Hospital | 511 | 804.8 | 421.7 | 79.23 | 1,965 |
| Gas | 511 | 491.2 | 282.7 | 19.99 | 1,458 |
| Post | 511 | 711.3 | 377.2 | 21.24 | 2,078 |

**Source:** Accumulated and analyzed by the author

Figure 4.4 presents a classification of data sampling on residential property price based on CBRE criteria[18] [19]. It separates residential buildings in Bangkok by price per square meter into several categories. Furthermore, it adds that cluster 'upper' or higher often share following common qualifications: (1) Locating in an easily accessible area; (2) Locating in a nice location and providing high privacy to the residence; (3). Having a good building design, including building layout and interior decoration; (4) Having good construction standards and using high-quality materials; (5). Having a vast array of amenities, like swimming pool and fitness room; (6). Having enough elevators and good mechanical and electrical (M&E) systems; (7). Having a professional building management team; (8). Having adequate parking lots.

**Figure 4.4** Classification of Data Sampling Based on CBRE Criteria



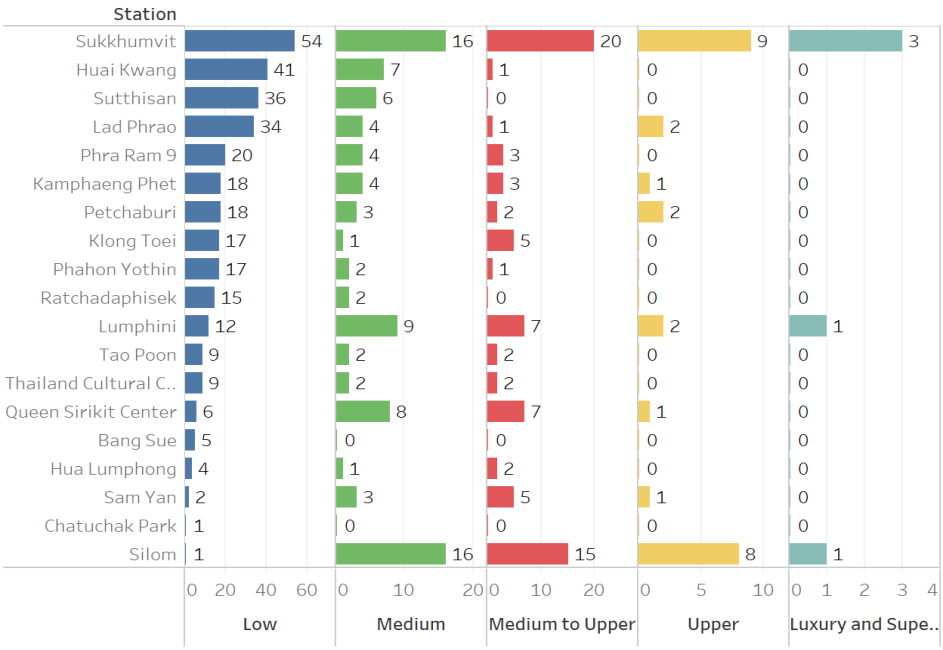

**Source:** Accumulated and analyzed by the author

[18] CBRE is a globally commercial real estate services and investment firm established in Thailand since 1988.

[19] All samplings are divided into 5 clusters by price per square meter: low (<70,000 THB), medium (70,000 – 89,999 THB), medium to upper (90,000 – 199,999 THB), upper (120,000 – 199,999 THB), and Luxury and super luxury (>120,000 THB).

According to Figure 4.4, it is a dual axis combination chart, classifying buildings into five clusters. On the left axis, the blue charts represent the number of buildings, while the orange curve shows the average value or price of buildings in each cluster (on the right axis). Starting with the blue chart, the majority of samples (319 buildings) are categorized in cluster 'Low'. The cluster 'Upper', 'Medium to Upper', 'Medium' has 89, 75, and 27 buildings, respectively. While the cluster 'Luxury and Super Luxury' has only five buildings. When deliberately considering between clusters, the trend in average value of building negatively correlates with the number of buildings. It exhibits that the average value or price of housings fluctuates between 44,810 and 255,470 baht per square meter.

**Figure 4.5** Classification of Data Sampling by the Closest MRT Blue Line Station




**Source:** Accumulated and analyzed by the author

Figure 4.5 exhibits the data sampling classified by the closest distance to MRT Blue Line Station. Many stations share similar pattern that the majority of samplings highly concentrate in 'Low' cluster with the exception of Sukhumvit, Silom, Lumphini, and Queen Sirikit Center Station. This may imply that those areas have

diverse groups of income level living together. The neighborhood of Sukhumvit and Silom Station, which accumulates various facilities and connects with manifold modes of transport, sometimes are called transit-oriented development area. Therefore, the property developers continuously launch many new projects in these prime locations to the buyer. Besides, the 'luxury or super luxury' condominiums in the sampling (5 buildings) appear around only these stations. Conversely, MRT Chatuchak Park Station, which can interchange to BTS Mo Chit Station, portrays quite different in land use. It does not have enough space for private use. The area around the station is surrounded by parks, weekend markets, metro maintenance buildings, and government places.

## 4.4 Empirical Analysis and Results

### 4.4.1 Spatial Weight Matrix

To construct spatial regression models, it needs to find the spatial weight matrix (W) that shows the correlation among all spatial units. The spatial weight matrix is the key component to create spatially explicit variables, such as spatially lagged variables. The software program namely GeoDa is employed to find it.



In the first step, the ID variable is necessary to be specified for each residential property; since the weight matrix must be matched with correct observations in the Shapefile. Later, the author has to choose the type of contiguity weight either the rook criterion[20] or the queen criterion[21]. In this research, the first order queen criterion is selected to generate a weight matrix because it makes the coordinates to become more relevant than the rook criterion. After finishing the

[20] **Rook Criterion** defines neighbor by the existence of a common edge between two spatial units.

[21] **Queen Criterion** defines neighbor as spatial units sharing a common edge or common vertex. Thus, it has often seen that the number of neighbors according to queen criterion will always be at least as large as for the rook criterion

whole process, it is saved into GAL file (.gal), which contains the number of neighbors and their identifiers. This format file, GAL, is easy to analyze in RStudio.

The result in Figure 4.6 demonstrates the characteristics of first-order queen contiguity weights on the price of residential property. It consists of 3,498 non-zero links from 511 sample coordinates. The average number of links is 6.7922 (See Figure 4.7- A light green bar chart with the highest frequency). There are 14 least connected regions with 3 links. Whereas, there is only one most connected region with maximum to 14 links.

**Figure 4.6** Characteristics of First Order Queen Weights

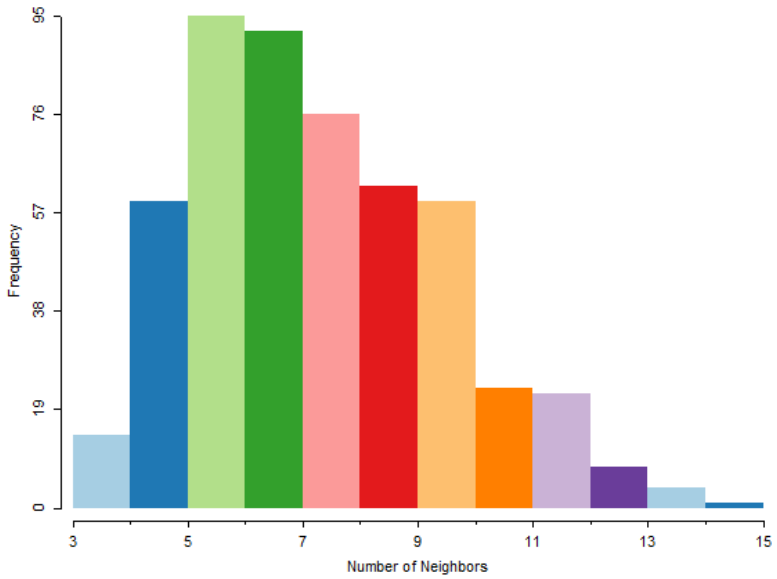
```
Characteristics of weights list object:
Neighbour list object:
Number of regions: 515
Number of nonzero links: 3498
Percentage nonzero weights: 1.31888
Average number of links: 6.792233
Link number distribution:

 3  4  5  6  7  8  9 10 11 12 13 14
14 59 95 92 76 62 59 23 22  8  4  1
14 least connected regions:
72 96 115 164 206 272 310 377 398 418 425 436 449 476 with 3 links
1 most connected region:
102 with 14 links

Weights style: W
Weights constants summary:
    n     nn  S0       S1       S2
W 515 265225 515 161.7992 2104.946
```

**Source:** Analyzed by the author

**Figure 4.7** First Order Queen Contiguity Weights Histogram




**Source:** Created by the author

Moving to the LISA Cluster Map[22], it is quite straightforward to explain. Each dot on the map represents the coordinate of residential properties. There are two levels of color showing the direction of autocorrelation. The stronger color displays a significantly positive global autocorrelation outcome, whereas, the paler color indicates a significantly negative autocorrelation outcome or surrounded by dissimilar values that occur near one another. For instance, the strongly red coordinates have a high-value of themselves and also have neighbors with high values (High- High). For the paler blue ones, they have low values themselves, however, they interact with high value neighbors instead (Low-High).

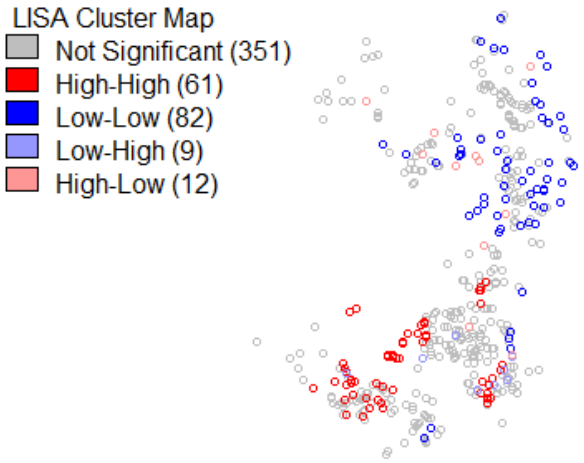
According to Figure 4.8, the LISA Cluster Map, it shows that there are 143 buildings having positive global autocorrelation, and 21 buildings having negative global autocorrelation with their neighbors. While the remaining 351 buildings are not significant. Nevertheless, this figure also displays interesting pattern of residential

[22] LISA (Local Indicators of Spatial Association) is the method to identify localized map region where data values are positively or negatively associated with neighbor regions. Both LISA cluster map and LISA Significance map can be generated on GeoDa.

settlement that this MRT Blue Line route serves both major groups of property owner, high-value and low-value property. The luxury and high-end residences likely are gathered in the downtown or around lower part of train route map; e.g. Silom, Lumphini, or Sukhumvit Station. On the contrary, those cheaper residences are concentrated around upper part of train route map, e.g. Huai Khwang, Sutthisan, or Lad Phrao Station.

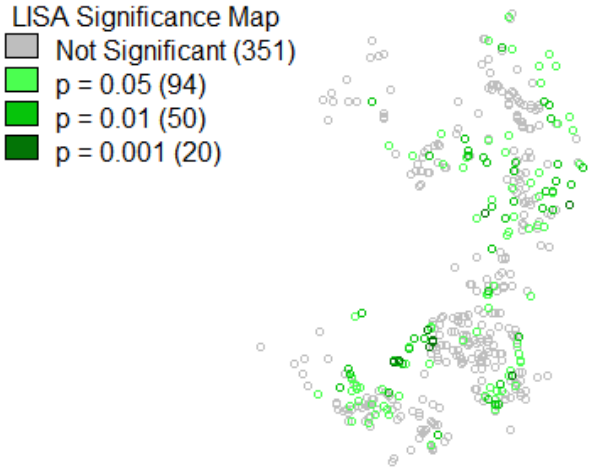
In Figure 4.9, the LISA Significance Map, it exhibits minutely to the statistical significance level of samples. There are 94, 50, and 20 buildings that are statistically significant at p-value level <0.05, <0.01, and <0.001, respectively. Note that a statistically significant result may be either very high or very low.

**Figure 4.8** LISA Cluster Map




**Source:** Created by the author

**Figure 4.9** LISA Significance Map




**Source:** Created by the author

**Table 4.5** Diagnostic Test for Spatial Autocorrelation on Weight Matrix

| | Moran-I | Lagrange Multiplier (LM) | | | | |
|---|---|---|---|---|---|---|
| | | LMlag | LMerr | RLMlag | RLMerr | SARMA |
| First Order Queen Contiguity | 0.3171 | 2.7799 | 3.8334 | 0.1737 | 1.2272 | 4.0071 |
| P-Value | 0.0000 | 0.0955 | 0.0502 | 0.6768 | 0.268 | 0.1349 |

**Source:** Analyzed by the author



Prior to Table 4.5, Moran-I test and Lagrange Multiplier (LM) test are deployed to test for spatial autocorrelation on spatial weight matrix calculated on GeoDa. The result shows that the P-Value of Moran-I has rejected the null hypothesis. There is a sign of positive autocorrelation among coordinates. It means one object has similar values and interacts to nearby objects. Besides, the P-Value of LMlag (0.0955) and LMerr (0.0502) also confirm the presence of spatial autocorrelation at a 90% confidence level. As a consequence, it can confirm reasonably to employ spatial econometric models in the estimation. A spatial weight matrix is then substituted in various forms of spatial econometric models and brought to eliminate bias that may cause by the spatial autocorrelation problem.

4.4.2 Econometric Estimation

Before starting to analyze regression models, the author wants to control the number of variables in the equation. Due to a large number of attributes, it may cause a multicollinearity problem in the estimation. Some explanatory variables may be highly correlated with other independent variables. It may report the inaccurate result. Besides, the coefficient estimates are unstable and difficult to interpret. Therefore, the variance inflation factors (VIF) test is taken to check whether each attribute should be added into the equation or not. It measures how much the variance of estimated regression coefficients is increased due to collinearity. By a rule of thumb principle, if VIF value of any variable is greater than 10, that variable will be considered to remove out of the equation first.

In the two tables below, they show result from the VIF test on OLS equations before and after removing a set of problematic variables. In Table 4.6, it shows the multicollinearity test before removing problematic variables out. Mean value of VIF is equal to 11.67. There are five variables having VIF value exceeding than 10. The distance between airport and property site (Airport_d) provides the highest VIF at 118.08, which shows a sign of serious multicollinearity. Thus, it should be firstly eliminated from the study. Later, the author decides to drop other two variables out: Sukhumvit CBD (Sukk_cbd_d) and Mosque. Although the Silom CBD and Rama-9 CBD provide very high VIF, yet the author wants to keep some central business district (CBD) variables. Since they can be used to elaborate the effect on urban sprawl and land use pattern. The Silom CBD (silom_cbd_d) represents the old CBD, whereas, the Rama9 CBD (Rama9_cbd_d) typifies for the new CBD. After removing these variables, the mean VIF is drastically lowered to 1.96, which is a satisfactory level to continuously analyze the econometric result. (See Table 4.7),

**Table 4.6** VIF Test on OLS Equation (Before Removing Problematic Variables)

| Variable | VIF | 1/VIF | Variable | VIF | 1/VIF |
|---|---|---|---|---|---|
| Airport_d | 118.08 | 0.008469 | Age | 2.27 | 0.439973 |
| Silom_cbd_d | 109.31 | 0.009149 | Bus_d | 2.26 | 0.443240 |
| Sukk_cbd_d | 31.31 | 0.031935 | Unit | 2.19 | 0.457180 |
| Mosque | 15.09 | 0.066270 | EIA | 2.17 | 0.461100 |
| Rama9_cbd_d | 13.19 | 0.075791 | Hospital | 2.01 | 0.497040 |
| Temple | 3.16 | 0.316953 | Fitness | 1.87 | 0.535484 |
| Floor | 2.98 | 0.335272 | Aream2 | 1.78 | 0.562394 |
| Police | 2.78 | 0.360260 | Bl_station_d | 1.77 | 0.564680 |
| Interchange | 2.69 | 0.371886 | Ground | 1.63 | 0.614194 |
| Metromall | 2.66 | 0.376148 | Gas | 1.56 | 0.639672 |
| School | 2.64 | 0.379242 | Church | 1.56 | 0.640814 |
| Market | 2.59 | 0.385987 | Shop | 1.46 | 0.685791 |
| University | 2.40 | 0.416593 | Wifi | 1.23 | 0.813280 |
| Plaza | 2.39 | 0.418306 | Parking | 1.16 | 0.859617 |
| Post | 2.30 | 0.435694 | **Mean VIF = 11.67** | | |

**Table 4.7** VIF Test on OLS Equation (After Removing Problematic Variables)

| Variable | VIF | 1/VIF | Variable | VIF | 1/VIF |
|---|---|---|---|---|---|
| Silom_cbd_d | 3.13 | 0.319344 | Bus_d | 1.91 | 0.522464 |
| Floor | 2.89 | 0.345449 | Hospital | 1.86 | 0.538712 |
| School | 2.36 | 0.423984 | Fitness | 1.84 | 0.542875 |
| Market | 2.34 | 0.427846 | Metromall | 1.76 | 0.567456 |
| Post | 2.27 | 0.440452 | Rama9_cbd_d | 1.75 | 0.570401 |
| Temple | 2.24 | 0.445845 | Aream2 | 1.67 | 0.597119 |
| Interchange | 2.23 | 0.447582 | Ground | 1.56 | 0.640240 |
| Age | 2.17 | 0.461412 | Gas | 1.43 | 0.701387 |
| Unit | 2.16 | 0.462474 | Shop | 1.42 | 0.703211 |
| Plaza | 2.13 | 0.468920 | Church | 1.35 | 0.740489 |
| EIA | 2.12 | 0.471727 | Wifi | 1.20 | 0.836738 |
| University | 2.07 | 0.483301 | Parking | 1.16 | 0.864122 |
| Police | 2.01 | 0.498682 | **Mean VIF = 1.96** | | |

Having a trial test on OLS equation by gradually adding variables in each model, the purpose is to observe the differences in the sign and size of the coefficient, standard deviation, and statistical significance (See Table 4.8). Overall, the entire models are highly consistent even after adding variable sets indefinitely. As shown in model 1, it adds only spatial attributes. The adjusted R-squared equals to 0.02171. Then, the structural attributes, location attributes, and neighborhood attributes are gradually added in model 2, 3, and 4, respectively. All models demonstrate that the R-squared and adjusted R-squared value have increased when more and more variables are added. In this case, the model 4 provides the highest adjusted R-squared at 0.725, which is regarded as the most fitted model.

**Table 4.8** Four OLS Regression Results with Different Specifications

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|
| | Coefficient | Std. | Coefficient | Std. | Coefficient | Std. | Coefficient | Std. |
| (Intercept) | 10.9087*** | (0.03568) | 10.72126*** | (0.18996) | 11.25014*** | (0.15717) | 11.14071*** | (0.17516) |
| d1 | 0.36613** | (0.14856) | 0.13270 | (0.10656) | 0.28200*** | (0.08740) | 0.35296*** | (0.08874) |
| d2 | 0.28835*** | (0.10804) | 0.15626** | (0.07789) | 0.25251*** | (0.06458) | 0.30282*** | (0.06493) |
| d3 | 0.15617 | (0.13301) | 0.04830 | (0.09499) | 0.11333 | (0.07684) | 0.13024* | (0.07533) |
| d4 | 0.25670** | (0.10357) | 0.12846* | (0.07314) | 0.11603* | (0.05954) | 0.14159** | (0.05985) |
| d5 | 0.04116 | (0.10968) | 0.01397 | (0.07728) | 0.02492 | (0.06209) | 0.03633 | (0.06235) |
| d6 | -0.00313 | (0.10968) | -0.04220 | (0.07783) | 0.03538 | (0.06366) | 0.07317 | (0.06366) |
| d7 | 0.03813 | (0.10968) | 0.00976 | (0.07740) | 0.04685 | (0.06270) | 0.01661 | (0.06161) |
| d8 | 0.03459 | (0.10222) | 0.05626 | (0.07202) | 0.06564 | (0.05694) | 0.09025 | (0.05590) |
| d9 | -0.06051 | (0.11520) | 0.04170 | (0.08119) | -0.00334 | (0.06437) | 0.00268 | (0.06341) |
| d10 | -0.14056 | (0.12431) | -0.05109 | (0.08789) | -0.02203 | (0.06948) | 0.00724 | (0.06793) |
| Age | | | -0.03139*** | (0.00248) | -0.03785*** | (0.00201) | -0.03669*** | (0.00197) |
| Floor | | | 0.01913*** | (0.00213) | 0.01297*** | (0.00173) | 0.01167*** | (0.00173) |
| Aream2 | | | -0.00001 | (0.00000) | -0.00000 | (0.00000) | -0.00000 | (0.00000) |
| Parking | | | 0.18847 | (0.18266) | 0.14178 | (0.14626) | 0.12030 | (0.14176) |
| Unit | | | -0.00037*** | (0.00009) | -0.00019** | (0.00008) | -0.00009 | (0.00008) |
| Fitness | | | 0.26012*** | (0.05889) | 0.12389*** | (0.04731) | 0.13822*** | (0.04657) |
| Shop | | | -0.22836*** | (0.04255) | -0.10735*** | (0.03452) | -0.10452*** | (0.03392) |
| Eia | | | 0.01756 | (0.04980) | 0.06945* | (0.03948) | 0.07175* | (0.03863) |

| | | | | |
|---|---|---|---|---|
| Interchange | | | 0.17472*** (0.03534) | 0.08894** (0.03982) |
| Metromall | | | -0.01629 (0.03229) | -0.04914 (0.03607) |
| Bus_d | | | -0.00015** (0.00007) | -0.00019** (0.00008) |
| Rama9_cbd_d | | | 0.00002** (0.00001) | 0.00003** (0.00001) |
| Silom_cbd_d | | | -0.00007*** (0.00001) | -0.00008*** (0.00001) |
| School | | | | -0.00001 (0.00005) |
| University | | | | 0.00004 (0.00003) |
| Police | | | | -0.00003 (0.00003) |
| Plaza | | | | 0.00002 (0.00003) |
| Ground | | | | 0.00024*** (0.00006) |
| Market | | | | 0.00013*** (0.00003) |
| Temple | | | | -0.00004 (0.00004) |
| Church | | | | 0.00005 (0.00004) |
| Hospital | | | | -0.00012*** (0.00004) |
| Gas | | | | -0.00008 (0.00005) |
| Post | | | | 0.00004 (0.00005) |
| $R^2$ | 0.04089 | 0.53575 | 0.71433 | 0.74287 |
| Adj. $R^2$ | 0.02171 | 0.51876 | 0.70084 | 0.72450 |
| Num. obs. | 511 | 511 | 511 | 511 |
| RMSE | 0.55853 | 0.39173 | 0.30886 | 0.29639 |

***p < 0.01, **p < 0.05, *p < 0.1

4.4.3 Model Comparison: Spatial and Non-Spatial Models



Table 4.9 compares and illustrates the goodness of fit of all regression equations, both spatial and non-spatial econometric models. Owing to the lowest Akaike Information Criterion (AIC) at 241.206, it points out that the Spatial Error Model (SEM) is the most suitable model for interpretation of coefficients. In fact, the most fitted model can vary differently in each research hinging on the research question, selected sample group, or even other geographic factors, such as GWR Model (Efthymiou & Antoniou, 2013) and SAR Model (Goffette-Nagot, Reginster, & Thomas, 2011; Xu et al., 2016). Also, Table 4.9 says that a spatial error coefficient $(\lambda)$ of SEM has statistical significance at p< 0.05. In contrast, none of the spatial autoregressive coefficient ($\rho$) has statistical significance.

**Table 4.9** Model Comparison: Goodness of fit

| | OLS | SAR | SEM | SEDM | SDM | SAC |
|---|---|---|---|---|---|---|
| Rho $(\rho)$ | - | 0.08436 | - | - | 0.09983 | 0.00885 |
| Lamda $(\lambda)$ | - | - | 0.15297** | 0.09409 | - | 0.14317 |
| Observations | 511 | 511 | 511 | 511 | 511 | 511 |
| Parameters | 36 | 37 | 37 | 71 | 71 | 38 |
| Log Likelihood | - | - 84.25109 | - 83.60294 | - 67.17713 | - 67.00074 | - 83.59786 |
| AIC (Spatial) | 243.07503 | 242.50219 | 241.20589 | 276.35426 | 276.00148 | 243.19571 |

In Table 4.10, the author considers only column 3 (SEM) since it is the most fitted model compared to other models. The coefficients in column SEM show the 90 percent statistical significance of d1, d2, d3, and d4[23]. It can be concluded that the residential properties, settled within 0-400 meter by walk from the closest MRT Blue Line station, yield convenience and benefit of having the station settled nearby. It accordingly means that the price of those properties located more than 400 m. farther away does not receive any positive impact of having a train station adjacent nearby. What is more, the spatial attribute's coefficients exhibit a good sign for tax estimation. The even closer to the train station, the higher price premium is.



Mostly, the coefficients of variable generally result sign and size as expected. Starting with the structural attributes, age shows a negative sign to the property price. Every year increase in age is associated with a 3.68 percentage-point reduction in price. It yields the same sign of coefficient like literature of Bohman and Nilsson (2016), and Martínez and Viegas (2009). While price augments by 1.13% for every floor higher (Yan et al., 2012). For those amenities provided in the building, having fitness room increases the residential price by 14.54%. But, having minimart declines price by 10.53%. Prior to a case study in Taipei, Chiang, Peng, and Chang (2015)

[23] The d1, d2, d3, and d4 represent proxy variables of the 0-100, 101-200, 201-300, and 301-400 meter distance between the MRT station and proximity site, respectively.

discovered that the availability of convenience store is related to low-quantile property price rather than high-quantile property price. The residents in high-priced property tend to be more flexible to access shops in another suburb.

Next, the EIA attribute represents that each building having more than eight floors or twenty-one meters high has to submit the Environmental Impact Assessment (EIA) report to the government. The price of buildings having to submit EIA report is thus higher by 6.56% than those that have not. The result clearly sees that the additional burden of preparing report and time cost is shifted forward from the real estate investor to the buyers through price. Hence, some buildings are chosen to construct less than the criterion so as to avoid the punishment by the law.

Similarly, some stations directly link with other lines that the passenger can change train bounded for different destination, i.e. connecting with MRT Purple Line at Taopoon Station or BTS Dark Green Line at Silom Station. The result exhibits if the buildings are adjacent to the interchange station, the price is higher by 9.13% than those are not. Moreover, the central business district (CBD) is another indicator to exemplify urban development and land appreciation. This study has included the distance from the property site to the CBD, which consists of the old CBD (Silom District) and the new CBD (Rama 9 District). Every meter closer to the new CBD leads 0.002% higher in price. Conversely, the price is lower by 0.008% for every meter closer to the old CBD. However, both CBD coefficients are questioned by the author why they have a very little impact on price. The reason may be due to the perceived negative impacts, such as traffic or nuisance, outweighed by the benefit of having various amenities and services nearby (Mathur & Ferrell, 2013). Whilst, a meter closer to the closest bus stop (bus_d) leads to a minor reduction in price by 0.019%.

Lastly, the neighborhood attribute, it shows that public space is crucial for people who live in the heart of Bangkok as well. Every meter nearer to the ground

space and market has an effect on a higher in property price by 0.023% and 0.012%, respectively. The positive impact of public space or 'ground' on the property price is consistent with the research of Agostini and Palmucci (2008). Whereas, every meter closer to the hospital is associated with a 0.011 percentage-point reduction in price. Whilst other interesting factors, such as educational institution, department store, religious place, post office, or police station, all do not have statistical significance.

Lastly, prior to Table B.1 in the Appendix B, the author has also assumed that the anticipation effect at the time before opening service, such as during the construction approval by the cabinet in 1994 or contract signing with the construction bidders in 1999, may affect an increase in property price beforehand. A special robustness is employed to check on the data sampling. Basically, it separates sampling into two groups, before and after the inauguration of MRT Blue Line in 2004. The finding is very interesting that the price of all buildings built before 2004 do not receive any impact from this event. All spatial coefficients (d1-d10) in 'before' column is not statistically significant at 90 %. But for, the 'after' column has statistical significance for d1- d4, which give the size and sign of coefficients like in Table 4.10.

**Table 4.10** Spatial and Non-spatial Regression Results

| | OLS | SAR | SEM | SEDM | SDM | SAC |
|---|---|---|---|---|---|---|
| (Intercept) | 11.1407*** | 10.2050*** | 11.1467*** | 11.5345*** | 10.4145*** | 11.0481*** |
| | (0.17516) | (0.60463) | (0.17380) | (0.51683) | (0.95759) | (0.89630) |
| d1 | 0.35296*** | 0.32104*** | 0.34051*** | 0.25313** | 0.24917** | 0.33817*** |
| | (0.08874) | (0.08692) | (0.08858) | (0.12204) | (0.09942) | (0.09199) |
| d2 | 0.30282*** | 0.28591*** | 0.29673*** | 0.20546** | 0.20367** | 0.29549*** |
| | (0.06493) | (0.06250) | (0.06573) | (0.10192) | (0.07920) | (0.06691) |
| d3 | 0.13024* | 0.11380 | 0.12386* | 0.05945 | 0.05728 | 0.12269 |
| | (0.07533) | (0.07231) | (0.07424) | (0.09691) | (0.07797) | (0.07519) |
| d4 | 0.14159** | 0.12889** | 0.14110** | 0.09652 | 0.09665 | 0.13993** |
| | (0.05985) | (0.05708) | (0.06007) | (0.08736) | (0.06006) | (0.06096) |
| d5 | 0.03633 | 0.02499 | 0.03056 | 0.00169 | 0.00147 | 0.02978 |
| | (0.06235) | (0.05907) | (0.06214) | (0.08690) | (0.02464) | (0.06259) |
| d6 | 0.07317 | 0.06406 | 0.06270 | 0.00026 | -0.00071 | 0.06246 |
| | (0.06366) | (0.06053) | (0.06355) | (0.08040) | (0.06354) | (0.06366) |
| d7 | 0.01661 | 0.01225 | 0.00906 | 0.00138 | 0.00124 | 0.00909 |
| | (0.06161) | (0.06066) | (0.06101) | (0.07687) | (0.05952) | (0.06093) |
| d8 | 0.09025 | 0.08441 | 0.08885 | 0.05749 | 0.05882 | 0.08838 |
| | (0.05590) | (0.05294) | (0.05498) | (0.06735) | (0.05347) | (0.05512) |
| d9 | 0.00268 | -0.00419 | -0.00019 | -0.02520 | -0.02403 | -0.00069 |
| | (0.06341) | (0.01480) | (0.06172) | (0.07012) | (0.06189) | (0.06193) |
| d10 | 0.00724 | 0.00155 | 0.00417 | -0.03972 | -0.03846 | 0.00381 |
| | (0.06793) | (0.06588) | (0.06579) | (0.07072) | (0.06570) | (0.06589) |
| Age | -0.03669*** | -0.03655*** | -0.03676*** | -0.03651*** | -0.03656*** | -0.03676*** |
| | (0.00197) | (0.00188) | (0.00189) | (0.00192) | (0.00188) | (0.00189) |
| Floor | 0.01167*** | 0.01145*** | 0.01131*** | 0.01123*** | 0.01112*** | 0.01132*** |
| | (0.00173) | (0.00167) | (0.00168) | (0.00171) | (0.00170) | (0.00168) |
| Aream2 | -0.00000 | -0.00000 | -0.00000 | -0.00001** | -0.00001* | -0.00000 |
| | (0.00000) | (0.00000) | (0.00000) | (0.00000) | (0.00000) | (0.00000) |
| Parking | 0.12030 | 0.13551 | 0.13487 | 0.16333 | 0.17039 | 0.13547 |
| | (0.14176) | (0.13618) | (0.13520) | (0.14210) | (0.13709) | (0.13564) |
| Unit | -0.00009 | -0.00010 | -0.00010 | -0.00009 | -0.00010 | -0.00010 |
| | (0.00008) | (0.00007) | (0.00007) | (0.00007) | (0.00007) | (0.00008) |
| Fitness | 0.13822*** | 0.13707*** | 0.14543*** | 0.11528*** | 0.11758*** | 0.14489*** |
| | (0.04657) | (0.04443) | (0.04468) | (0.04449) | (0.04408) | (0.04478) |
| Shop | -0.10452*** | -0.10554*** | -0.10532*** | -0.11521*** | -0.11518*** | -0.10544*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.03392) | (0.03257) | (0.03264) | (0.03279) | (0.03258) | (0.03267) |
| Eia | 0.07175* | 0.06868* | 0.06562* | 0.05820 | 0.05616 | 0.06572* |
| | (0.03863) | (0.03721) | (0.03704) | (0.03704) | (0.03715) | (0.03708) |
| Interchange | 0.08894** | 0.08637** | 0.09127** | 0.07516 | 0.07598* | 0.09089** |
| | (0.03982) | (0.03817) | (0.04157) | (0.06045) | (0.04392) | (0.04144) |
| Metromall | -0.04914 | -0.03980 | -0.04703 | -0.00116 | -0.00217 | -0.04628 |
| | (0.03607) | (0.03472) | (0.03777) | (0.05975) | (0.01083) | (0.03824) |
| Bus_d | -0.00019** | -0.00018** | -0.00019** | -0.00033** | -0.00033** | -0.00019** |
| | (0.00008) | (0.00007) | (0.00008) | (0.00013) | (0.00013) | (0.00008) |
| Rama9_cbd_d | 0.00003** | 0.00002** | 0.00002** | -0.00001 | -0.00001 | 0.00002** |
| | (0.00001) | (0.00001) | (0.00001) | (0.00009) | (0.00004) | (0.00001) |
| Silom_cbd_d | -0.00008*** | -0.00008*** | -0.00008*** | -0.00003 | -0.00003 | -0.00008*** |
| | (0.00001) | (0.00001) | (0.00001) | (0.00009) | (0.00007) | (0.00001) |
| School | -0.00001 | -0.00001 | -0.00001 | 0.00005 | 0.00006 | -0.00001 |
| | (0.00005) | (0.00005) | (0.00006) | (0.00011) | (0.00011) | (0.00006) |
| University | 0.00004 | 0.00004 | 0.00004 | -0.00013 | -0.00013 | 0.00004 |
| | (0.00003) | (0.00003) | (0.00003) | (0.00009) | (0.00008) | (0.00003) |
| Police | -0.00003 | -0.00003 | -0.00003 | 0.00005 | 0.00006 | -0.00003 |
| | (0.00003) | (0.00003) | (0.00004) | (0.00009) | (0.00009) | (0.00004) |
| Plaza | 0.00002 | 0.00002 | 0.00001 | 0.00009 | 0.00009 | 0.00002 |
| | (0.00003) | (0.00003) | (0.00004) | (0.00009) | (0.00009) | (0.00004) |
| Ground | 0.00024*** | 0.00022*** | 0.00023*** | 0.00007 | 0.00006 | 0.00022*** |
| | (0.00006) | (0.00005) | (0.00006) | (0.00011) | (0.00011) | (0.00006) |
| Market | 0.00013*** | 0.00012*** | 0.00012*** | -0.00004 | -0.00005 | 0.00012*** |
| | (0.00003) | (0.00003) | (0.00003) | (0.00009) | (0.00009) | (0.00003) |
| Temple | -0.00004 | -0.00004 | -0.00004 | 0.00020** | 0.00019** | -0.00004 |
| | (0.00004) | (0.00004) | (0.00004) | (0.00010) | (0.00009) | (0.00004) |
| Church | 0.00005 | 0.00004 | 0.00005 | 0.00004 | 0.00004 | 0.00005 |
| | (0.00004) | (0.00004) | (0.00005) | (0.00009) | (0.00008) | (0.00005) |
| Hospital | -0.00012*** | -0.00011*** | -0.00011** | -0.00006 | -0.00005 | -0.00011** |
| | (0.00004) | (0.00004) | (0.00004) | (0.00010) | (0.00008) | (0.00004) |
| Gas | -0.00008 | -0.00007 | -0.00008 | -0.00011 | -0.00010 | -0.00008 |
| | (0.00005) | (0.00005) | (0.00006) | (0.00010) | (0.00010) | (0.00006) |
| Post | 0.00004 | 0.00003 | 0.00003 | -0.00006 | -0.00006 | 0.00003 |
| | (0.00005) | (0.00005) | (0.00005) | (0.00010) | (0.00009) | (0.00005) |
| Rho | | 0.08436 | | | 0.09983 | 0.00885 |
| | | (0.05197) | | | (0.07573) | (0.07910) |

| | | | | |
|---|---|---|---|---|
| Lambda | 0.15297** | 0.09409 | | 0.14317 |
| | (0.07653) | (0.07928) | | (0.10479) |
| lag.d1 | | 0.30092 | 0.26784 | |
| | | (0.24467) | (0.23019) | |
| lag.d2 | | 0.13224 | 0.10272 | |
| | | (0.16987) | (0.14237) | |
| lag.d3 | | 0.07547 | 0.06916 | |
| | | (0.20398) | (0.17326) | |
| lag.d4 | | 0.05582 | 0.04578 | |
| | | (0.15316) | (0.12617) | |
| lag.d5 | | 0.10686 | 0.09548 | |
| | | (0.16198) | (0.13146) | |
| lag.d6 | | 0.18667 | 0.17653 | |
| | | (0.14703) | (0.11843) | |
| lag.d7 | | 0.24325 | 0.23356* | |
| | | (0.15983) | (0.13762) | |
| lag.d8 | | 0.02328 | 0.00626 | |
| | | (0.14321) | (0.06593) | |
| lag.d9 | | 0.03522 | 0.03544 | |
| | | (0.15845) | (0.13445) | |
| lag.d10 | | 0.01629 | 0.01022 | |
| | | (0.16844) | (0.12307) | |
| lag.age | | 0.00396 | 0.00747 | |
| | | (0.00509) | (0.00575) | |
| lag.floor | | 0.00885** | 0.00756* | |
| | | (0.00400) | (0.00400) | |
| lag.aream2 | | -0.00002** | -0.00002** | |
| | | (0.00001) | (0.00001) | |
| lag.parking | | -0.68337 | -0.68206 | |
| | | (0.44155) | (0.42893) | |
| lag.unit | | 0.00018 | 0.00018 | |
| | | (0.00019) | (0.00018) | |
| lag.fitness | | -0.16477 | -0.17648 | |
| | | (0.12087) | (0.11669) | |
| lag.shop | | -0.00875 | 0.00217 | |
| | | (0.08295) | (0.03145) | |
| lag.eia | | 0.15761 | 0.14559 | |

| | | |
|---|---|---|
| | (0.09900) | (0.10138) |
| lag.interchange | 0.00433 | -0.00495 |
| | (0.08376) | (0.02840) |
| lag.metromall | -0.02835 | -0.02260 |
| | (0.08115) | (0.04750) |
| lag.bus_d | 0.00020 | 0.00022 |
| | (0.00019) | (0.00018) |
| lag.rama9_cbd_d | 0.00006 | 0.00005 |
| | (0.00010) | (0.00004) |
| lag.silom_cbd_d | -0.00006 | -0.00005 |
| | (0.00009) | (0.00007) |
| lag.school | -0.00004 | -0.00005 |
| | (0.00016) | (0.00015) |
| lag.university | 0.00018* | 0.00017* |
| | (0.00010) | (0.00010) |
| lag.police | -0.00010 | -0.00010 |
| | (0.00012) | (0.00011) |
| lag.plaza | -0.00006 | -0.00006 |
| | (0.00011) | (0.00011) |
| lag.ground | 0.00019 | 0.00018 |
| | (0.00016) | (0.00016) |
| lag.market | 0.00022* | 0.00021* |
| | (0.00011) | (0.00011) |
| lag.temple | -0.00028** | -0.00027** |
| | (0.00012) | (0.00012) |
| lag.church | 0.00004 | 0.00004 |
| | (0.00013) | (0.00011) |
| lag.hospital | -0.00006 | -0.00005 |
| | (0.00012) | (0.00011) |
| lag.gas | 0.00005 | 0.00006 |
| | (0.00015) | (0.00015) |
| lag.post | 0.00016 | 0.00016 |
| | (0.00013) | (0.00012) |

4.4.4 Tax Revenue Simulation

Table 4.11 is the simulation showing the expected income from the windfall tax collection. Basically, the author has applied the calculation model from the research of Xu et al. (2016). Owing to the regression result in Table 4.10, spatial coefficient (or price premium) of the SEM model is adopted as the main factor for tax base calculation. The closer the building is to the train station, the higher is the price premium. The price premium of d1, d2, d3, and d4 are 34.05%, 29.67%, 12.39%, and 14.11%, respectively. The average value of residential property in the d1 (87,276.78 baht/ Square Meter) is the most expensive compared to other groups. With regard to the tax base, it calculates from the price premium multiplied by the average value of properties (Baht/ Sq. m.) and total area (Sq. m.). In terms of the tax rate, it uses both flat rate and progressive rate to assess the expected income.

However, the draft version of the Windfall Tax Act (See Appendix A) has not clearly described much in detail. It is still ambiguous in the form of tax calculation. The author, therefore, has to set additional assumptions to control the outcomes. Firstly, given the fact that each property in the experiment will be traded and changed hand only once throughout the study period. Secondly, assume that it has no change in the pattern of land or building use, and also holds the inflation rate at a constant level. Thirdly, due to the maximum tax threshold specified in the draft act, the applicable tax rate is therefore maintained at no more than 5%.



Next, the author deploys the construction cost of the MRT Orange Line Project (Western Section) so as to consider the proportion of this tax contribution to future urban railway project. In 2017, the state Enterprise Office estimated the total investment value of this line at 124,249 million baht. The reason to raise this project as a case study is that the entire route is an underground structure similar to the MRT Blue Line. Flyvbjerg, Bruzelius, and Van Wee (2008) explained that the all-in cost

for the new line is different depending on the type of the metro alignment. The construction cost per route-kilometer is US$ 15-30 million for ground-level metro, US$ 30-75 million for elevated metro, and US$ 60-180 million for underground metro. Hence, this project, the MRT Orange Line, is most appropriate to study compared with other projects in M-MAP1; because most lines are normally built in the form of the elevated structure.

For the tax revenue simulation, when collecting by flat rate tax at 0.5%, 1%, 2%, 4% and 5% (column A-E), the government will receive expected tax revenue in the range between 33.08 and 330.85 million baht, which is account for only 0.027-0.27% of gross expenditure of MRT Orange Line (Western Section) Project. However, by virtue of windfall tax, it should not punish all groups of property owner equally due to unequal in price premium value. The author hence suggests that they should be levied tax at a progressive rate depending on the threshold distance to MRT station instead. When using progressive rate (column F-I), the government will acquire gross tax revenue around 34.6298–173.1514 million baht. Such revenue can subsidize approximately between 0.0278 and 0.1394 percent of gross expenditure on the aforementioned project.

**Table 4.11** Tax Revenue Simulation: Using SEM Coefficients

| Di | Price Premium | Average Value (Baht/Sq. m) | Total Area (Sq. m) | Flat Rate | | | | | Progressive Rate | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | [A] 0.5% | [B] 1% | [C] 2% | [D] 4% | [E] 5%** | [F] | | [G] | | [H] | | [I] | |
| | | | | | | | | | Rate | Tax Revenue (Million Baht) | Rate | Tax Revenue (Million Baht) | Rate | Tax Revenue (Million Baht) | Rate | Tax Revenue (Million Baht) |
| **d1** | 0.34051 | 87,276.78 | 60,163 | 8.9398 | 17.8796 | 35.7592 | 71.5184 | 89.398 | **1%** | 17.8796 | **2%** | 35.7592 | **4%** | 71.5184 | **5%** | 89.398 |
| **d2** | 0.29673 | 77,887.04 | 111,438 | 12.877 | 25.7549 | 51.5098 | 103.0196 | 128.7745 | **0.5%** | 12.877 | **1%** | 25.754 | **2%** | 51.5098 | **2.5%** | 64.3872 |
| **d3** | 0.12386 | 69,160.08 | 98,663 | 4.2258 | 8.45163 | 16.9032 | 33.8064 | 42.2581 | **0.25%** | 2.1129 | **0.5%** | 4.2258 | **1%** | 8.4516 | **1.25%** | 10.5645 |
| **d4** | 0.14110 | 74,101.32 | 134,690 | 7.0413 | 14.0827 | 28.1655 | 56.331 | 70.4139 | **0.125%** | 1.7603 | **0.25%** | 3.5206 | **0.5%** | 7.0413 | **0.625%** | 8.8017 |
| Total Tax Revenue (Million Baht) | | | | 33.085 | 66.17 | 132.34 | 264.68 | 330.85 | 34.6298 | | 69.2596 | | 138.5211 | | 173.1514 | |
| % of expenditure in M-MAP1 Project MRT Orange Line- Western Section (124,249 Million Baht) | | | | 0.027 | 0.053 | 0.1060 | 0.213 | 0.265 | 0.0278 | | 0.0557 | | 0.111 | | 0.1394 | |

# Chapter 5

# Conclusion

## 5.1 Research Conclusion

The study of how far from the train station should be taxed uses a case study of the Bangkok MRT Blue Line. There are two important objectives. First, it targets to examine the impact from a set of attributes that has influenced on residential property price, particularly for the impact of having MRT station locating nearby. Second, the other ultimate goal is to capture the increment value incurring from the public infrastructure, and present in the form of tax collection guideline. To assess tax revenue, the author ushers the price premium or the coefficient of spatial attributes of the most fitted model. Finally, the revenue collecting from this tax will finance future transport investment. All findings could be summarized as follows.

Considering from the spatial econometric result, the statistical significance of the spatial coefficients (d1-d4) represents that only the price of residential properties located within 400 meter from the closest train station receives a positive addition from the adjacency to MRT Blue Line. Besides, the values of coefficient or price premiums are much higher when the properties are closer to the train station. It can accordingly explain that the properties located even closed to the station grant the benefits and conveniences rather than those properties settled farther away.



Moreover, other attributes also give signs of coefficient similar to the literature that have been previously studied. The residential property is even more expensive for a newer and higher building. The interchange station, offering travel options and creating convenience, is highly associated with the increment in price. While the alternative mode of public transport like public bus sends a minor impact on price. Similar to CBD coefficients, they barely have an influence on price as well.

The costs of EIA Act compliance also push the property price higher. Whereas, the public spaces- i.e. ground space, sport field, or public park- entirely send positive addition to price.

Next, this paper has employed a technique of the value capture method called “Tax Increment Financing (TIF)” to predict the revenue from windfall tax (Thomas, 2018). In the tax simulation, the author sets the condition for tax assessment as close as to what is specified in the act. When collecting by flat tax rate, the government will receive expected tax revenue in the range between 33.08 and 330.85 million baht. But, when using progressive tax rate, the government will acquire gross tax revenue around 34.63 to 173.15 million baht. Such revenue could subsidize around 0.027 to 0.265 percent of gross expenditure of the MRT Orange Line (Western Section).

**5.2 Policy Suggestions**

Generally, a low proportion of Thai people, which is primarily Bangkok resident, can access to comfortable and efficient public transport service. While the source of funding in the form of tax is gathered from the taxpayer throughout the country. It seems unfair for the rest of people. The concept of value capture method would be employed to examine the increment value on land and property after operating public transport projects. The collected revenue from this tax will be directly used to develop the public transport system in the regional cities.

Thanks to the draft version of Windfall Tax Act (See Appendix A), it is expected to collect tax from individual or jurisdiction person that possesses land or property located within five kilometers from the state infrastructure. Although this tax has marked such a significant leap for the country’s fiscal system, this study finds that some principles in this act are still quite unclear in a manifold. Hence, this literature desires to introduce suggestions so as to improve this tax law as follows:

Firstly, the author is concerned that if the government imposes a windfall tax on the property owners located over a walking distance of 400 meters from the MRT Blue Line, some taxpayers might be punished by the law exceedingly than necessary. Therefore, the government agency should frame the taxpayer groups more evidently.

Secondly, when considering the price premium, they gradually decline with the distance farther away from the train station. Hence, in reality, the government should not equally collect windfall tax from all property owners by using the flat rate, but the progressive rate instead. Due to the ease of travelling from MRT, the property located even closer to the train station should be punished by imposing higher tax.

Thirdly, it is a known fact that after all multi-color MRT lines in Bangkok have been activated, they will have a huge impact on the reshaping of land use and city plan. This new tax should be readily available to charge the augment in value of land and property from additional infrastructures, especially for the station connecting between urban railway lines. The author suggests to calculate the tax base from 'the sum of price premium of all modes of public infrastructure', instead.



Lastly, the author is concerned about the uncertainty in delivering this tax income to the state annually. What is more, this windfall tax should be designed for the specific purpose with a clear allocation of subsidy, which sometimes may be called 'earmarked tax.' Thus, it is such crucial that the government should establish the 'ad hoc fund' specifically for this tax in order to prevent it being used for other purposes.

## 5.3 Limitations of the Research

- Data Quality Problem

The official property appraisal database from the Treasury Department, Ministry of finance is not up-to-date. Its data shows that some residential property prices are lagged behind between 1- 5 year compared to the actual market price. As a result, when using this information for tax assessment, the real estate owners may actually pay the tax lower than the reality. It inversely affects to revenue forecast by the state as well. Although this data set has a quality discrepancy, the government sector still intends to evaluate actual tax from this data set.

- Narrow Data Sampling

Though the researcher has known that the state projects have an impact on each type of residential property differently. Using all types of housing to analyze, the result might not yield as expected. The author thus controls the unobserved heterogeneity problem so that the outcome would become more accurate. However, it basically uses only residential high-rise buildings and analyzes the effect from only a single of MRT Line to the price. Therefore, the result of this article needs to be reassessed before making policy in the future.



- Hypothesis for Tax Assessment

Due to the latest draft of the Windfall Tax Act, it cannot confirm the decision of government agency on tax collection guideline, tax rate, or even taxpayers target group. As long as the proposal has not yet been enacted to the law, the legal conditions can be changed at any time. Hence, the conditions for tax assessment are based upon the author's thought. Of course, the tax assessment may not match what will be actually enforced in the near future. But the author deeply hopes that this work can provoke a good starting point to study the cost and benefit of this tax approach in Thailand context.

## 5.4 Suggestions for Future Study

Considered as a good sign that all governments in past decades have raised public access to public transport as an urgent agenda for the country. Presently, many transport projects receive construction approval from the government, and are soon to be opened for the public use by the next couple of years. The success of these transport projects, especially for urban railway transit, will have a tremendous effect on increasing travel options, raising the quality of life of Thai people, and creating economic values. One of these projects, worth to mention hereby, is MRT Blue Line extension projects (Hua Lamphong- Laksong, and Taopoon- Thaphra). They are going to start in-service by the mid of 2019 and 2020, respectively. This line will be operated as a loop line and will fully connect the people who live along two sides of the Chaophraya River.

Therefore, the readers who are interesting in this research may extend it further by enlarging the sample group of property adjacent to the extension route of the MRT Blue Line. Collecting the data between two periods of time, before and after operation of those new stations, might add a lot of new dimensions to the result. Due to the imperfection of data, this study thus cannot collect the data in two periods of time. It still has to analyze based upon the current price but not a percentage change in price. Furthermore, the future study can use the quasi-experimental design to examine, e.g. Difference in Difference (DID), or interrupted time-series.

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# Appendix A

## Draft Version of Windfall Tax Act

Technically, a windfall is a word to describe something that seemingly drops from the sky and opens up a whole new range of possibilities (HBDobbin, 2015). The common types of windfall are, for instance, inheritance, bonuses, lottery winnings, or tax rebates. When mentioning the windfall tax, the definition given by Investopedia is "a tax levied by the government against certain industries when economic conditions allow those industries to experience above-average profits." In India, a windfall tax is going to be levied on companies like Oil and Natural Gas Corporation (ONGC) and Oil India (OIL). The purpose is to lessen the rising petrol and diesel price in a moment kicking cross $70 per barrel. Then, the revenue would be used to pay fuel retailers so that they can absorb cost beyond the threshold level. Similarly, in the UK, this tax is applied when the oil price is above $75 per barrel (LiveMint, 2018).

Apart from the oil producers, the windfall tax can be also collected on other goods and services. On July 11th 2018, the Thai cabinet led by General Prayuth had approved the principle of real estate windfall tax bill, collecting from inflated property price driven by transport infrastructure projects. Note that those projects must be completed after the bill is promulgated. In the basic principle of this law, this new tax will be levied on both individual and corporate owners for residential and commercial purposes.

Charoenkitraj (2018) has summarized basic measurements of this act as follows. This tax will be imposed on the land and condominium units that are located with five kilometers from the public infrastructure project and have a value exceeding 50 million baht. It will be charged on two following groups: (1). the owners

of taxable land and condominiums and (2) the real estate developers that own the properties waiting to be sold. While the tax base assesses from the increased value of the property due to the infrastructure project. The ceiling of the tax rate will be not exceeding more than five percent. The actual tax base will be set out later under the royal decree. Moreover, the tax is imposed every time the ownership is transferred and only once upon the completion of the project.

# Appendix B

## Robustness Test on Spatial Error Model (SEM)

**Table B.1** Robustness Test: MRT Blue Line Inauguration in 2004

| | **Before** | **After** |
|---|---|---|
| (Intercept) | 10.49357*** | 11.36354*** |
| | (0.30457) | (0.30429) |
| d1 | 0.30862 | 0.35000*** |
| | (0.25520) | (0.08569) |
| d2 | 0.02656 | 0.31251*** |
| | (0.15085) | (0.06546) |
| d3 | 0.00431 | 0.15409** |
| | (0.16571) | (0.07513) |
| d4 | 0.11834 | 0.10522* |
| | (0.12265) | (0.06228) |
| d5 | 0.09219 | 0.04881 |
| | (0.10487) | (0.06691) |
| d6 | 0.10018 | 0.09925 |
| | (0.12229) | (0.06547) |
| d7 | -0.05268 | 0.05115 |
| | (0.11332) | (0.06564) |
| d8 | -0.01694 | 0.08145 |
| | (0.08240) | (0.06494) |

| | | |
|---|---|---|
| d9 | 0.08713 | -0.01683 |
| | (0.08543) | (0.07546) |
| d10 | 0.00962 | 0.16835 |
| | (0.08326) | (0.09280) |
| Age | 0.00032 | -0.04873*** |
| | (0.00516) | (0.00461) |
| Floor | 0.01064*** | 0.01345*** |
| | (0.00286) | (0.00184) |
| Aream2 | -0.00000 | 0.00000 |
| | (0.00000) | (0.00001) |
| Parking | 0.19499 | -0.04134 |
| | (0.13976) | (0.27615) |
| Unit | -0.00023 | -0.00019** |
| | (0.00014) | (0.00009) |
| Fitness | 0.16384*** | 0.09633 |
| | (0.05550) | (0.07043) |
| Shop | -0.02534 | -0.10954*** |
| | (0.05359) | (0.03736) |
| Eia | 0.06036 | 0.11437*** |
| | (0.07983) | (0.04054) |
| Interchange | 0.22098** | 0.07059* |
| | (0.08857) | (0.04280) |
| Metromall | -0.19920*** | 0.01999 |

| | | |
|---|---|---|
| | (0.07056) | (0.03982) |
| Bus_d | -0.00007 | -0.00023*** |
| | (0.00015) | (0.00008) |
| Rama9_cbd_d | 0.00000 | 0.00002** |
| | (0.00003) | (0.00001) |
| Silom_cbd_d | -0.00010*** | -0.00008*** |
| | (0.00002) | (0.00001) |
| School | 0.00013 | -0.00007 |
| | (0.00011) | (0.00006) |
| University | 0.00000 | 0.00002 |
| | (0.00006) | (0.00004) |
| Police | -0.00010 | -0.00005 |
| | (0.00008) | (0.00004) |
| Plaza | -0.00001 | 0.00005 |
| | (0.00007) | (0.00004) |
| Ground | 0.00002 | 0.00024*** |
| | (0.00010) | (0.00006) |
| Market | 0.00003 | 0.00014*** |
| | (0.00007) | (0.00004) |
| Temple | -0.00001 | -0.00005 |
| | (0.00007) | (0.00004) |
| Church | -0.00001 | 0.00007 |
| | (0.00010) | (0.00005) |

| | | |
|---|---|---|
| Hospital | -0.00001 | -0.00010** |
| | (0.00008) | (0.00005) |
| Gas | -0.00008 | -0.00005 |
| | (0.00010) | (0.00006) |
| Post | 0.00005 | 0.00005 |
| | (0.00009) | (0.00006) |
| Lambda | 0.52308* | 0.07732 |
| | (0.29160) | (0.10421) |
| Num. obs. | 150 | 361 |
| Parameters | 37 | 37 |
| Log Likelihood | -2.40603 | -27.95585 |
| AIC (Spatial model) | 78.81206 | 129.91169 |
| LR test: statistic | 10.66999 | 0.55594 |
| LR test: p-value | 0.00109 | 0.45590 |

***p < 0.01, **p < 0.05, *p < 0.1

# VITA

| | |
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