PROPERTY TAX IN THAILAND: A CASE FOR VALUE CAPTURE TAXATION

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ABSTRACT

Title of Dissertation	Property Tax in Thailand: A Case for Value Capture Taxation
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This study presents a new financial resource for Thailand called "Property Value Capture" mechanism. The mechanism is applied to finance public infrastructure project through capturing either some or all of the "excess value" or the incremental value of real estate generated by a public scheme. This mechanism not only reduces government's total expenditures for public infrastructure projects, but also reduces the tax burden on the overall population.

The first step in this study is to investigate the amount of economic rent for condominium projects located along the sky train station (Light Green Lines Extensions, On Nut to Bearing station) .The datasets used in this research have been collected from two sources. First, the data on market sale price and structural characteristics of the condominiums was obtained from property owners and brokers of the condominiums by interview and website search for the period from December 2013 to August 2014. Four Hundred forty-one (441) condominium units were randomly selected for our survey and were used to estimate the impact of the sky train station and other factors on property values. This study have applied the concept of Hedonic Pricing Method (HPM) to estimate the implicit price of the Light Green Lines Extensions and other factors by using two difference type of the functional forms; 1) log-linear, and 2) linear Box-Cox functional form. The implicit prices (or economic rents) of condominium units are found to be between 150.46 to 195.04 baht per unit for every meter closer to the sky train station. Therefore, condominiums located directly adjacent to the sky train station were roughly 150,460 to 195,040 baht

more than an identical condominium located 1,000 meter away when considering the average value.

The total amount of the economic rent for condominium projects located within 1,000 meter, 1,500 meter, and 2,000 meter of the sky train station is estimated roughly at 2,359,072,495.61 baht, 2,988,644,281.37 baht, and 3,378,377,226.87 baht respectively. While, the number of condominium projects in each area was 49, 59, and 69 projects respectively. The excess real estate value was derived directly from the construction of the Light Green Line Extensions.

The second step in this research study is to apply a concept of a "betterment tax" imposed on property holders who received a direct and unique benefit from the Light Green Lines Extension in three assessment areas; 1,000 meter, 1,500 meter, and 2,000 from the sky train station. The total betterment tax burden from our estimation of 49 condominium projects, located within the 1,000 meter assessment area was equivalent to 592,704,431.85 baht or 25.12 percent of the economic rent. The total tax burden of the 59 condominium projects, located within the 1,500 meter assessment area equaled 408,918,475.90 baht or 13.68 percent of the implicit price. Whereas, the total amount of tax burden for condominiums located within the 2,000 meter assessment area, or 69 condominiums projects; was equal to 314,439,864.17 baht or 9.31 percent of the economic rent.

The successful implementation a betterment tax strategy in Thailand depends upon four issues; 1) the betterment tax rate, should not be excessively high; otherwise the taxpayer will oppose a public development project in their neighborhood, 2) for social acceptance, the local government must actively work to promote the benefits, positive aspects and fairness of the tax, 3) Thai government should improve and provide a necessary technology for increasing an efficiency of land appraisal system, and 4) the Land Department should appraise a value of real-estate every year in order to obtain the real market price and other attributes of real-estate.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Public transportation projects are an unprofitable business. Therefore, in most developing countries, funding for a transportation investment project in a capital city like Bangkok is usually allocated from the central government budget (Ubbels and Nijkamp, 2002). In this sense, project funding comes from all revenue sources such as taxes, fees, and even from public debt. Funding for a mega project typically comes from external versus internal debt because project costs are extremely high. Therefore, the total cost of investment is carried by the whole economy. However, the benefits derived, especially from a public transportation project, are typically enjoyed by a smaller, more localized segment of the total population who live near the development project either as commuters or as residents. Understandably, citizens living outside of the development area wonder why they must share in the cost of a transportation system that delivers no direct benefit to them. Many view this as an inequity of the government system. Moreover, many argue that in the absence of the localized project, the money could be used for other development projects that would deliver a broader scope of benefits to a larger segment of the total population. For example, the Thai government can apply the same budget to finance other public infrastructure projects like sanitary sewer lines in urban areas and improvements in agriculture logistics or irrigation systems in rural areas. Generally, it is recognized that inadequate infrastructure development leads to slower economic growth and a loss of competitiveness. To restore fairness in taxation, public policymakers should create new financial mechanisms that reimburse the public for development projects. The reimbursement would come from the segment of the population who realizes the greatest value or gain from the development project. This can be achieved by using the "beneficiary pays principle". The "beneficiary pays principle" promotes a simple concept: those who receive a windfall gain from a public development project should also share in the cost of that project through an appropriate supplemental tax structure that reimburses the public for part or all of the development project cost.

As a general comment regarding transportation development projects, improved accessibility to public transportation produces a variety of direct and indirect benefits including a reduction in travel time, an increase in leisure time, and an increase in property values for land and buildings adjacent to the development project. Data from many countries confirm the relationship between public transportation projects and enhanced property values. Research shows that transportation projects can be profitable provided they are structured to return public investment funds from the primary beneficiaries of the project. For example, in Jakarta, Cervero and Susantono (1999) indicated that offices located within a half kilometer of a freeway interchange rented for approximately 3,823 rupiah more per square meter per month than offices located 2.5 kilometers away from an interchange. McMillen and McDonald (2004) found the value of residential structures which were located within 1.5 miles of the Midway Rapid Transit Line in Chicago increased in absolute value by approximately $6,000 per structure as compared to similar structures located farther away from the transit line.

In Eastern Massachusetts, it was estimated that the value of properties located in municipalities with one or more rail stations are between 9.6 percent to 10.1 percent higher than other properties located in municipalities without a station (Armstrong and Rodriquez, 2006). Data from Thailand (Kaiwan Wattana, 2007) shows that an office building located one kilometer farther from a mass transit station generates approximately 19 baht per square meter less in monthly rent than an office building located closer to a transit station. Lastly, the construction of new public infrastructures, such as roads, railways and highways will produce a corresponding rise in land rents (Coleman and Grimes, 2010). So, a real capital gain or "unearned incremental value" increase for landowners will occur as a result of infrastructure projects. In absence of any land taxes, the windfall gains arising from the unearned incremental land value gains have always been a major source of speculation and an incentive to hold vacant lands rather than develop them. This type of land speculation provides no real benefit to society.

In order to eliminate dangerous land speculation and encourage development, including transportation investment, policymakers can capture a portion of the surplus windfall gains from property owners through "value capture" mechanisms by using a land value tax, a land value incremental tax, a capital gains tax, a special assessment district or a betterment tax, etc. The value capture mechanism allows the government to capture some or all of the infrastructure investment from the property owner who realized an unearned incremental gain in property adjacent to a public infrastructure project (Batt, 2001). Value capture strategies are based on the "beneficiary pays principle" where the property owners who received the unearned gain from an infrastructure investment, without making an investment in the public project, pays a portion of the project cost through value capture mechanism. These strategies discourage land speculation. Policymakers can use the value capture method to finance more public infrastructure development because these methods stretch the development dollar. Moreover, the value capture mechanism will increase the holding cost to landowners and developers; an increase in holding cost will motivate landowners and developers to develop rather than hold their land for speculative gains (Batt, 2001). Currently, several countries are confronted with financial constraints, including high inflation in construction costs; these factors hinder the expansion of existing transportation systems and the development of new systems. The recent trend in many areas such as Europe, the United States and Latin America is to reduce government support of public transportation by imposing land value methodologies (Ubbels and Nijkamp, 2002). The best examples of successful public transportation projects are found in Brazil, Columbia, and Uruguay where roads have been constructed using value capture strategies (Smith and Gihring, 2006). In the Colombia Despaz case, Otoya and Loaiza (2000) estimated the revenue from the land value increment tax in the zoning area to be about $8.341 billion.

Thailand is not only challenged by funding public infrastructure projects, but is also challenged by land holding activities. Currently, the two major causes of land holding in Thailand are: 1) asymmetric information. That is, rent seeking land speculators who possess insider information obtained from government sources on public infrastructure projects before the information reaches the public domain (Thailand Development Forum, 2013). The land speculator, armed with insider information and intent on taking all the economic rent from the public development project rushes to purchase available land in the targeted development area before the project becomes public knowledge. Moreover, some landlords with political power can even dictate the type and location of the infrastructure project. The rent seeking land speculator armed with the asymmetric information hinders healthy income distribution and creates inequality among citizens. 2) The absence of an efficient and equitable tax system (Lunta Uttamapokin, 2010). Even though Thailand has a variety of land taxes which include a local development tax, a building and land tax, and a specific business tax, these tax policies do not solve either the rent seeking land speculation problem, or the income distribution problem because their purpose, process and tax rate are not designed to address these problems. Relative to the local development tax: the tax base, the four year tax period, the tax rate which is extremely small (Suksai Nussara, 2013) are insufficient to deter the land speculation problem. Relative to the building and land tax, this tax is imposed on property owners at the rate of 12.5 per annum on the annual cost; however, these tax policies are out-of-date and inappropriate for current conditions (Thammagit Kwanguer, 2010). Further, the tax base is often underestimated and is not an accurate reflection of the real market value of land or structure. When considering the specific business tax, this tax is levied on individuals who sell their property, especially condominiums when holding the property for less than five years. The tax is computed on the selling price at the rate of 3.3 percent. Selling expenses are not considered when computing the specific business tax. This tax is viewed as an unfair tax because it is levied on all real estate sales, even if the property owner sold at a loss. Therefore, Thailand needs new tax mechanisms to solve the funding problem for public infrastructure projects and land speculation problem. A value capture tax might be the best answer to address these two issues in Thailand.

In the case of Thailand, the utilization of value capture taxation for recouping part or all of the public investment has never occurred. Although the Seventh National Economic and Social Development Plan of 1992-1996 did imposed the collection of a special fee from landowners who benefitted from public infrastructure project in order to recover project costs (Office of the National Economic and Social Development Board, n.d.); however, policymakers have never utilized this policy as a general practice. Thailand lacks efficient tools to support a mega project like a new public transportation system because most of the funding resources come from general taxes. Even though most economists usually argue that the general tax increases the tax burden on many taxpayers who never receive a direct benefit from the project; economists also argue that it creates inequities and distortions in the Thai economy.

Specific to Thailand, most literatures presented only empirical evidence on property value creation, rather than the practical aspects of property value capture. Even though some researchers, such as Saksith Chalermpong (2007) and Kaiwan Wattana (2007), have recommended that the Thai government should legislate a value capture mechanism for funding public projects, none of the literature systematically analyzed a policy that would be effective in capturing property value gains.

In this study, we will apply the idea of a beneficiary pays principle to refinancing existing public project through property value capture taxation which is collected directly from the beneficiaries of the public transportation project, the Light Green Lines Extension (On Nut to Bearing Station), based upon their geography proximity to the project. As previously mentioned, the public infrastructure projects produce an increase in property and land values so the property owner will receive more economic rents than other landowners with properties located farther away for the public project. In absence of the value capture mechanisms this will lead to an increase in a rent seeking from land speculation. Therefore, in order to refinance a public transportation project and reduce the rent seeking from land speculation, we should capture a portion of the windfall gain from the property owners who benefitted from the project, but made no investment in the project.

The purpose of this study is to find the answer to two key questions: 1) how much an impact of the public transportation scheme on the value of adjacent properties? And 2) what is an appropriated property value capture tax rate to recover the public transportation scheme?

1.2 Research Question

As previously mentioned, the construction of a new public transport system, such as a highway, railway, or transit station etc., has the greatest value uplift on properties adjacent to the public development project. Hence, the windfall gains, or economic rents, will belong to the property owners who did not invest in the project. The benefit of increased economic rent motivates developers to collect lands and properties located in proximity to the new public development scheme for the purpose of speculation. As stated, speculation provides no benefit to society. In order to reduce land speculation and return a portion of the public investment in the development project to the public, a value capture mechanism should be implemented. Therefore, the study attempts to answer these questions:

1) How much an impact of the public transportation scheme on the value of adjacent properties?

2) What is an appropriated property value capture tax rate to recover the public transportation scheme?

1.3 Objective of the Study

There are two key objectives of this study. They are:

1) To measure the property value change associated with transport schemes.

2) To estimate an appropriated property value capture tax rate in order to refinance the public transport projects through property value uplift.

1.4 Contribution of Research

1) Policymakers can develop ideas and mechanisms from this research to capture the property value increment for refunding the public transportation project.

2) The two causes of land holding; the property value capture mechanism impedes rent seeking from land speculation and devalues asymmetric information on public infrastructure projects.

1.5 Conceptual Model

There are two steps for study: The first step is to develop the property value measurement method, and the second step is to create the property value capture mechanism model. The details are demonstrated in Figure 1.1.

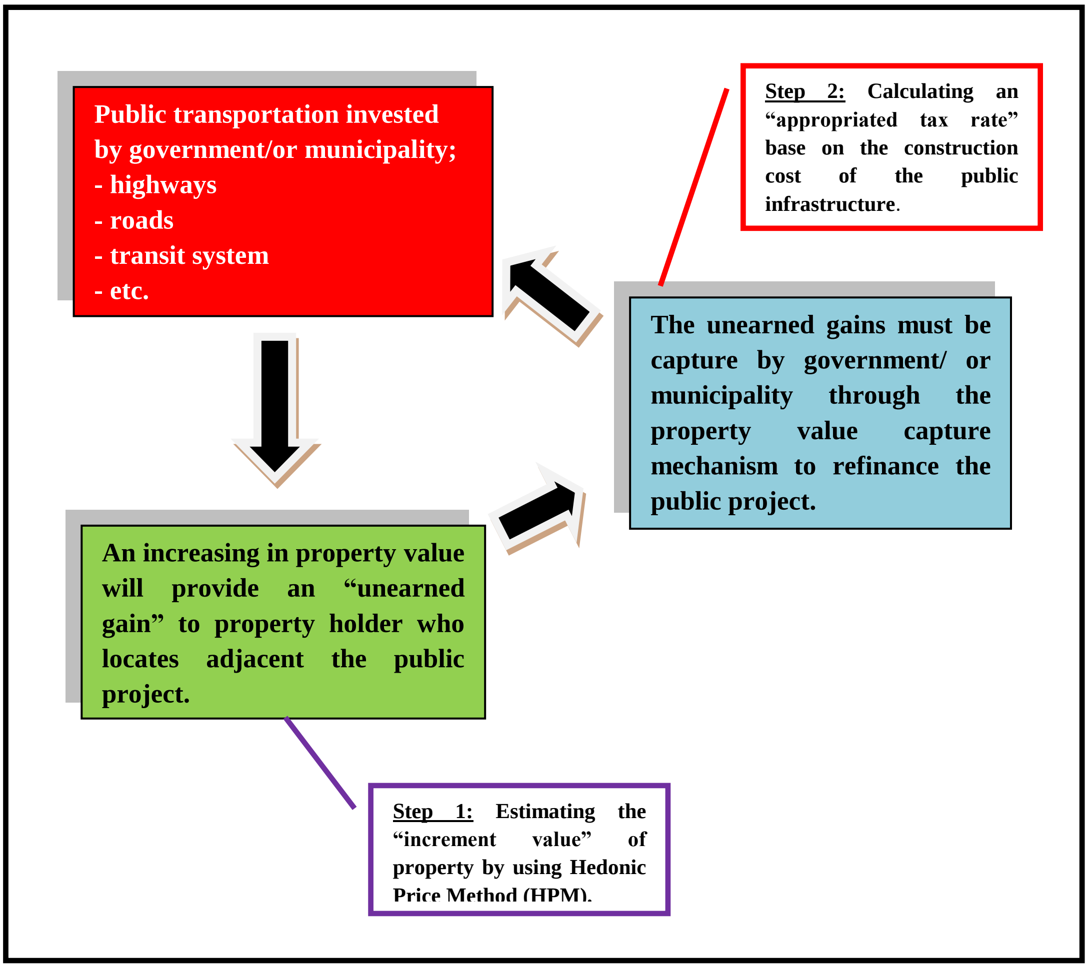


Figure 1.1 Conceptual Framework of the Study

1.6 Scope of the Study

This study is focused on two aspects. The first aspect is to investigate the impact of the Light Green Lines Extensions (On Nut to Bearing Station), in terms of implicit price; or economic rent, of the project through the value gains of adjacent properties which are locate along the lines. While the second aspect is to estimate an appropriate property value capture tax rate that will be collected from property owners who receives a windfall gain from the project in order to recover the costs of project. For population, this study defined the target population as any condominium that is located in two districts, Pra Khanong distirct and Bang Na district, which the sky train stations are connected to. This study randomly sampled four-hundred and forty-one (441) condominium units.

CHAPTER 2

LITERATURE REVIEW

The main objective of a “Property Tax in Thailand: A Case for Value Capture Taxation” is to estimate an appropriate property value tax rate for refinancing of a public transport project through property value creation. Therefore, the literature review must include the following three main concepts: 1) empirical evidence on the property value uplift effect of public transportation project, 2) empirical evidence on the methodology used to estimate the property value creation, and 3) the concept of value capture and public infrastructure financing.

2.1 Empirical Evidence on the Property Value Up-lift Effect of Public Transportation Project

Several empirical researches have found a relationship between transportation improvement and the change in property value in urban areas, which is referred as “value creation”. It is important to understand the concept of "accessibility" because accessibility is an important component of value creation.

Accessibility is defined as the ease and comfort of reaching the desired destination, such as, shopping destinations, employment, or educational institutions (Lari et.al (2009). Transportation networks like roads, railways, highways and transit systems, are designed create a quick and convenient connection of people to desired destinations. Therefore, people can save travel time and cost through a good transportation connection. Households will utilize the benefit of the time savings by adding a new activity with family-members and friends, or enjoy more personal leisure time. It is also possible that households will move to a location which offers greater accessibility to a public transportation system; for example, a transit station. That is why the land and real estate with greater accessibility to an improved transportation system has a higher value than properties with poor accessibility.

However, the impact of accessibility to a public transportation system is not equal for all users. Individuals who do not own a car will immediately benefit from improved accessibility to a public transportation system versus the individual who owns a car receives a lesser benefit from the transportation system (Salon and Shewmake, 2010).

Several studies demonstrate the impact of transportation on property value. The studies found that property location and corresponding value are strongly related. Investment in a new transport infrastructure will alter a location by improved accessibility, including changes in land values (Henneberry, 1998). Many researchers indicate that land value and home prices will be higher when located in areas with greater accessibility to desirable travel destinations such as workplace or a central business district (CBD). Because the transportation costs are reduced and time is saved, households are willing to pay a higher price for properties located closer to a transportation system. Nevertheless the magnitude of public transportation impact on the increased land value depends on: 1) the type of service; for instance: road, railway, or bus, 2) the distance of the property to the public infrastructure, 3) the transportation alternative, and 4) the quality of the service (Salon and Shewmake, 2010).

Based on the work of Levinson (Lari et.al, 2009), the association between transportation systems and land uses, in a term of an accessibility, are identified by "feedback loops", which affect all of the different players in these systems. The feedback loops are represented in Figure 2.1. (Note: the direction of the feedback loops between different set of the transportation are represented by the arrows, and the (+/-) signs indicate whether the feedback effects are positive or negative). Most transportation networks continuously evolve overtime, so households and firms need to respond to these changes and accessibility by changing their location. Therefore, we can say that accessibility is based on a dynamic concept. Figure 2.1 shows that increase in the capacity of each mode affects a rising demand that leads to increases in land value; while the congestion has the opposite effect in land value. Every household has budget constrains relative to time and money; if travel cost or travel time increases, households will reduce the number of destinations that they can access. Consequently, land values will be positively impacted by increased accessibility. The feedback effect moves on when increases in land value that are produced from increased accessibility in a given location produces more land development, which also has a positive effect on land values.

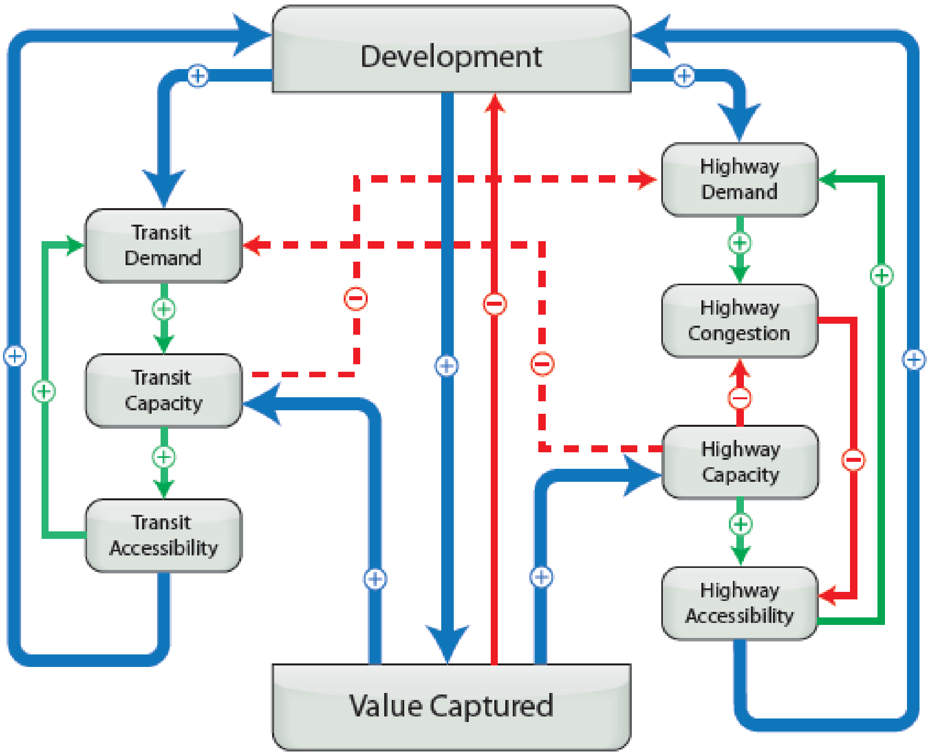


Figure 2.1 Feedback Loops in System of Transportation and Land Use

Source: Lari et.al, 2009.

In this study, the effect of public transportation on the property value will be considered in three categories; 1) value creation effect of transit systems, 2) value creation effect of highways and roads, and 3) value creation effect of other public transportations. The details are shown in the next topic.

2.1.1 Value Creation Effect of Transit Systems

Most of studies about the impact of public transportation on land value uplift usually focus on the relationship between land value and transit system such as, railway station, and commuter rail station, particularly in developed countries. The studies show that properties which were located near a transit system faced a higher value than comparable properties that lacked transit access. McMillen and

McDonald (2004) indicated that the value of houses in the sample area which were located within 1.5 miles of the Midway Rapid Transit Line, Chicago, increased in absolute value by about $6,000 per house when compared with similar properties at the sample boundary, 1.5 miles from the new transit line and the aggregate increase in property values to be $215.9 million in 1997 dollars, which is around half of the construction cost of the transit line. Further, Armstrong and Rodriguez (2006) evaluated the local and regional accessibility benefit of Commuter Rail Service in Eastern Massachusetts; they found that the value of the properties located in municipalities with one or more commuter rail station are between 9.6% and 10.1% higher than other properties located in municipalities without the station. Additionally, the results also show that value of properties located within a one-half mile buffer of a commuter rail station are 10.1% higher than these of properties located outside the buffer. In the Netherlands, Debrezion, Pels and Rietveld (2006) indicated that the distance to railways station has a significant positive impact on home prices; residential properties close to a station are 25% higher priced than residential properties located at a distance of 1.5 kilometers or more away from a station. When considering the effect of a transit system on property value in developing countries, we found that the results are similar to developed countries. Evidence from Thailand (Kaiwan Wattana, 2007) shows that an office building which is located one kilometer farther from the mass transit station costs approximately 19 baht per square meter in monthly rent less than the closer one. Moreover, it was found that the price of residential properties adjacent to a Bangkok transit system station increased to $10 (or Baht 38) for every meter closer to the station; whereas, the price elasticity with respect to the distance was approximately -0.09 (Saksith Chalermpong, 2007). However, results from Taiwan (Anderson, Shyr, and Fu, 2010) shows a minor impact between the new high speed railway (HSR) and the price of the residential property market because the HSR fares are expensive: the direct ticket cost is about 70% of the median monthly wage in Taiwan.

Furthermore, evidence from several counties shows the relationship between home prices and the anticipation of new public infrastructure construction. Henneberry (1998) evaluated the impact of the South Yorkshire Supertram in Sheffield on property values for the periods of 1988, 1993, and 1996. The results show that only in 1988, before the super tram was competed in 1995, was there a negative relationship between a properties' distance from the future route of the super tram and their price. Property prices near the future route were about 4% higher than other properties which were located farther away from the route. While in 1993, the location of properties had a direct relationship between their prices and distance from future super tram route. However, there was no significant relationship between super tram and properties prices in 1996. The finding of Henneberry (1998) was consistent with a study from Korea (Bae, Jun and Park, 2003). The researchers found that a distance from a new subway line (Line 5) in Seoul had impacted residential property values only prior to the line's opening. Further, evidence from Chicago (McMillen and McDonald, 2004) confirmed the anticipated effect of new transportation on property values as reported in other studies. Their finding indicated that the anticipated benefits of a new transit line began to be reflected in home prices 6 years before construction was completed in 1993. The home price gradient with respect to distance from nearest transit station increased from 4.2% before 1987 to 19.4% during the period from 1991 to 1996. However, they also found a decline in the price gradient to 9.8% during the period of 1997-1999.

2.1.2 Value Creation Effect of Highways and Roads

Many empirical studies show that highways and roads also create a value uplift on property. For example, highway access, calculated by travel time by highway to downtown in Philadelphia, affected home prices and the magnitude of the impact incurred during the 1980s (Voith, 1993). Evidence from Orange County, California (Boarnet and Chalermpong, 2001) shows that home buyers were willing to pay for the increased access when a new toll-road was provided. This confirms that the construction of toll-road network creates an accessibility premium which is reflected in home sale prices. The result from hedonic regression shows that after the threshold year, home price located further from both corridor showed a negative gradient. In the Foothill Transportation Corridor Backbone (FTCBB), home prices decreased by approximately $0.88 per foot whereas home price in the San Joaquin Hills Transportation Corridor (SJHTC) decrease by approximately $4.49 per foot.

Moreover, a finding from a developing country like Indonesia is not different from developed countries. Cervero and Susantono (1999) examined the accessibility benefit provided by major highway facilities to real estate value in term of commercial office rent in Jakarta. By using the nearest limited-access freeway interchange, expressed in distances of half kilometer increments to the proxy, the result shows that offices located within a half kilometer of a freeway interchange rented for around 3,823 Rupiah per m^2 per month more than offices located beyond 2.5 kilometers of an interchange.

2.1.3 Value Creation Effect of Other Public Transportations

Not much research has been done to examine the relationship between property values and other public transportation methods, such as a bus station and property values. However, a study from Hong Kong (So, Tse and Ganesan, 1997) indicated that the accessibility to minibuses, within a ten minute walking distance to a bus stop, was the most important factor in determining house prices for a large, middle-income class, residential area. Wang (2010) found that the Shanghai's rapid transit (Line 8) influenced residential properties in a positive way because the price of residential properties that were located within 0.5 km of the rapid transit station increase to 7.2 percent and the residential properties that were located within 0.5 to 1 km of the station increase by 3.2 percent. Another example came from Seoul where the results corresponds to the result from the Shanghai study; residential lands prices for land that was located within 300m of BRT stops increased by 10%; whereas, the land price for premium retail and non-residential property that was located within 150 meters increased by as much as 25 percent Cervero and Kang (2011) (A summary is shown by the Table 2.1).

Table 2.1 Summary of Result from the Empirical Evidence

Case/Location	Impact distance/ Assessment focus	Impact on	Impact	Source
Philadelphia, US	Accessibility to highway	House price	Positive	Voith (1993)
Hong Kong, China	Walking distance within 10 minutes to minibuses stop	House price of middle-income class	Positive	So et al. (1997)
Sheffield, UK	Proximity to South Yorkshire Super tram	Anticipation on property price	Negative value in 1988 (before the supertram was completed in 1995)	Henneberry (1998)
Jakarta, Indonesia	Accessibility to major highway	Commercial office rent	Positive Ropiah +3,823/m^2/month than offices located beyond 2.5 kilometers	Cervero and Susantono (1999)
Orange County, California, US	Accessibility to new toll-road	House price	After threshold year: Negative gradient -$0.88 per foot in FTCBB, - $4.49 in SJHTC for every meter further from the corridor	Boarnet and Chalermpong (2001)

Table 2.1 (Continued)

Case/Location	Impact distance/ Assessment focus	Impact on	Impact	Source
Seoul, Korea	New subway line (Line 5)	Anticipation on residential property value	Positive value only prior to the line's opening	Bae et.al (2003)
Midway Rapid Transit Line, Chicago, US	- Assumed impact area within 1.5 miles of the transit line	- House price	Positive +$6,000	McMillen and MacDonald (2004)
	- Proximity to new transit line	- Anticipation on House price gradient	- Positive +4.2% (before 1987) to 19.4% (period 1991-1996) - Decline in price gradient to 9.8% (1997-1999)	
Eastern Massachusetts, US	Access to commuter rail	Property value	Positive +9.6% - 10.1%	Armstrong and Rodriquez (2006)
Netherlands	Proximity to railway station and highway	Residential property value	Positive +25% within 1.5 kilometers	Debrezion et.al (2006)

Table 2.1 (Continued)

Case/Location	Impact distance/ Assessment focus	Impact on	Impact	Source
Bangkok, Thailand	Bangkok transit system	Residential property price	Positive +$10 (or +Baht 38) for every meter closer to the station	Saksith Chalermpong (2007)
Bangkok, Thailand	Mass transit station	Office rent	Positive +Baht19/m^2/ month within 1 kilometer	Kaiwan Wattana (2007)
Taiwan	Distance to high-speed railway station	Residential property price	Minor impact	Andersson, Shyr, and Fu (2010)
Shanghai, China	Urban rapid transit	Residential property value	Positive +7.2% within 0.5 km of a rapid transit system station	Wang (2010)
Seoul, Korea	Bus rapid transit	Land price for residential property	Positive +5% to 10% range within 300 m of BRT stops	Cervero and Kang (2011)
		Land price for retail and non-residential property	Positive + 3% to 26% range within 150 m of BRT stops	

2.2 Empirical Evidence on Methodology Estimated the Property Value Creation

The empirical methodologies used to evaluate the impact of transportation on property values have several features, which are based on quasi-experimental designs such as hedonic regression, spatial-econometric hedonic model, before/after study designs, control region comparison, and propensity score matching (Salon and Shewmake, 2010). The most widely used method for investigating the relationship between public transportations and property values is the "Hedonic Regression" analysis, which was first introduced by Rosen (1974) to estimate the accessibility effect of public transportation on property or land value. Many researchers have adopted hedonic analysis in their works such as So et al. (1997), Henneberry (1998), Bae et.al (2003), and, Cervero and Kang (2011). The hedonic price method has been used to estimate the impact of various kinds of public transportation, for instance: bus, rapid transit, railway station, and subway on the different types of property values, including single-family residential property, commercial real-estate property, and land. Many studies have been used transaction price, asking price, sale price, assessed price, and monthly rent. Several measures of accessibility have been considered, such as, walking time to nearest subway station, straight-line distance to the nearest toll-road, or walking distance to the nearest stops. Local accessibility, such as, walking time to nearest rail station has been taken account while various studies have been concerned with regional accessibility. For instance, a central business district (CBD), and employment sub-centers, which are reflected in the economic activity of a locations (Saksith Chalermpong, 2007).

The empirical studies usually employ two types of data; the first type is a temporal variation which can be used to explore how properties were valued before and after improvement, and researchers can apply a cross sectional variation when they need to determine the premium of property values located near public transportation, however some studies can be contain both type of data (Salon and Shewmake, 2010). When considering the appearance of hedonic techniques, several functional forms and econometric issues have been used. The most common functional forms consist of linear, semi-log, double log, and Box-Cox transformation.

When a data problem occurs, such as multicollinearity, heteroscedasticity, and spatial autocorrelation, advanced econometric techniques can be employed to correct the problem (Saksith Chalermpong, 2007).

Table 2.2 demonstrates the features of hedonic studies from various cities in difference countries; for example: Hong Kong (Mok, Chan, and Cho (1995), and So et al (1997), Sheffield (Henneberry, 1998), California (Boarnet and Saksith Chalermpong, 2001), Chicago (McMillen and McDonald, 2004), Massachusetts (Armstrong and Rodriquez, 2006), Seoul (Bae et.al (2003), and Cervero and Kang (2011)), Taiwan (Anderson, Shyr, and Fu, 2010), and Bangkok (Saksith Chalermpong (2007), and Kaiwan Wattana (2007). Different types of public transportation including mass transit rail, subway, highway, commuter rail, and buses services were studied. The majority type of property used in the estimation was residential property especially in single-family residential. The sample size ranges from 100 to 275,185 (Kaiwan Wattana, 2007; Boarnet and Saksith Chalermpong, 2001). Most empirical studies have used sale price, and asking price as property value proxies, except for Kaiwan Wattana (2007), and Cervero and Kang (2011) they used office rent, and assessed land value as a dependent variable for hedonic regression. The better representative for market equilibrium is the use of transaction price rather than other values; unfortunately transaction price is not always recorded, particularly in developing countries. Thus, some researchers prefer using asking price because it is easy to locate and clearly stated in various property for-sales magazines and promotional brochures (Henneberry, 1998), and Saksith Chalermpong (2007). Two types of data used to estimate the hedonic model in the literature are cross-section and multiyear. The multiyear data is used in some studies, such as Boarnet and Saksith Chalermpong (2001), Bae et.al (2003), and Cervero and Kang (2011) because it allows the researcher to gather data from the pre-construction period which represents the anticipatory price effect, during-construction period which is a disruptive effect, and realized effect which occurs after the transportation is completed and operational. To measure accessibility, most studies use the distance from the property location to nearest transit station. In order to calculate the nearest distance to transit point, majority works are done using the GIS method eg., (Henneberry, 1998, Boarnet and Saksith Chalermpong, 2001; Bae et.al, 2003 and Cervero and Kang, 2011). Finally, there are various functional forms of hedonic models, but the common forms used are linear, semi-log, and double log (eg., Bae et.al, 2003, Armstrong and Rodriquez, 2006 and Saksith Chalermpong, 2007). However, some studies (eg, Boarnet and Saksith Chalermpong, 2001) have applied Box-Cox transformation and heteroscedasticity for correcting the model (eg. Armstrong and Rodriquez, 2006; Bae et.al, 2003; Cervero and Kang, 2011). Moreover, a spatial autocorrelation was used by some researchers in the case of ordinary least squares may be a bias estimation or inefficient.

Table 2.2 Summary of Hedonic Methodologies Literature Review

Sources	Type of Transport	Property Type	Measure of Property Value	Data Type	Functional Forms and Econometric Issues	Measure of Accessibility	Number of Observation
So et al. (1997), Quarry Bay, Hong Kong, China	Mass transit railway (MRT) , buses, and minibuses	House price of class B units (40 m^2 – 69.9 m^2)	Transaction price	Cross sectional	Log – linear, Box-Cox transformation (hedonic regression)	Distance to nearest stations of the mass transit rail way (MRT), buses, and minibuses	1,234 obs., during 1 January 1994 to 31 December 1994
Henneberry (1998), Sheffield, UK	Super tram	House	Asking prices	Multiyear, organized data in cross-sectional pattern (estimating separate hedonic equations)	Linear, log – linear (hedonic regression)	- Straight-line distances from house to tram stops (m) - Straight-line distances from house to tram lines (m) (Note: the distance from house to these points were calulated by GIS method)	- 1,431 obs. for April 1988 - 1,767 obs. for April 1993 - 1,607 obs. for April 1996
Boarnet and Chalermpong (2001), Orange County, California, US	New toll-road	Single-family residential detached property	Home sale price	Multiyear	Linear, Box-Cox transformation (hedonic regression) and multiple sale price analysis	- Straight-line distances of each house to the nearest toll road on-ramp determined by GIS maps	275,185 obs., during 1988 to the first quarter of 2000

Table 2.2 (Continued)

Sources	Type of Transport	Property Type	Measure of Property Value	Data Type	Functional Forms and Econometric Issues	Measure of Accessibility	Number of Observation
Bae et.al (2003), Seoul, South Korea	New subway line (Line 5)	residential property value	Sale price	Multiyear (before and after construction); 1989, 1995, 1997, and 2000	Semi-log for correcting heteroscedasticity problem (hedonic regression)	- Distance from each property to Line 5 subway station, downtown (CBD), and to major sub centers estimate by GIS map.	241 obs. for each year or 956 obs. in total
McMillen and McDonald (2004), Chicago, US	New transit line	Single-family houses were located within 1.5 miles of the line	House price	Multiyear, (1983 to 1999 period)	Semi-log (hedonic regression)	- Distance to the nearest transit station - Distance to downtown Chicago (CBD) (Note: the distance from house to these points were estimated by GIS method)	- 17,034 of individual transactions obs. were .used for HP and; - 4,056 repeat sale obs. were used for estimating the indexes
Armstrong and Rodriquez (2006), Eastern Massachusetts, US	Commuter rail	Single-family residential detached property	Adjusted sales price	Cross section	- Linear and semi-log and; - double-log for correcting spatial autocorrelation and heteroscedasticity	For local accessibility: -Using shortest time path to nearest commuter rail station by foot and by car -Dummy variable = 1 if	1,860 transaction records within the price range between \$200,000 to \$500,000, during the four quarters of

Table 2.2 (Continued)

Sources	Type of Transport	Property Type	Measure of Property Value	Data Type	Functional Forms and Econometric Issues	Measure of Accessibility	Number of Observation
						-a property is located in a municipality which has at least one commuter rail service <u>For regional accessibility:</u> - Using schedule line – haul travel time for each station to downtown destination	1992 to the first quarter of 1993
Debrezion et.al (2006), Netherland	Railway station and highway	transaction price of residential houses	Residential property value	Multiyear, organized data in cross-sectional pattern (1996 to 2001 period)	Semi-log (hedonic regression)	- Distance to nearest railway station (m) - Distance to most frequently chosen railway station (m) - Frequency of trains per day (at the most frequently chosen station	Amsterdam station: (N = 40,326) Rotterdam station: (N = 17,772 Enschede station: (N = 5,997)

Table 2.2 (Continued)

Sources	Type of Transport	Property Type	Measure of Property Value	Data Type	Functional Forms and Econometric Issues	Measure of Accessibility	Number of Observation
						-Frequency of trains per day (at the nearest station - Distance to highway entry/exit (m) (Note: the distance from house to these points were estimated by GIS method)	
Chalermpong (2007), Banglok, Thailand	Urban rail transit	Multifami-ly residential property	Asking price	Cross section	Linear, log – linear (hedonic regression, spatial autocorrelation)	-Walking distance to nearest BTS station and nearest arterial roads are used for transportation accessibility - Number of BTS station to Silom, Sukumvit, and Siam is used for regional accessibility	236 obs., during September 2004 to March 2005

Table 2.2 (Continued)

Sources	Type of Transport	Property Type	Measure of Property Value	Data Type	Functional Forms and Econometric Issues	Measure of Accessibility	Number of Observation
Wattana (2008), Banglok, Thailand	Mass transit station	Commercial real-estate property	Office rent	Cross section	Linear, log-linear (hedonic regression, spatial autocorrelation)	- Distance from each property to transit stations, both BTS and MRT, arterial roads, and entrance and exit of expressway estimated by GIS maps	100 obs., during October 2007 to January 2008
Anderson, Shyr, and Fu (2010), Taiwan	High-speed railway	Residential property	Transaction prices	Cross section	Log- linear, semi-log, Box-Cox transformation form	- Distance to CBD (km.) - Distance to high-speed rail station (km.) - Distance to freeway interchange (km.) - Distance to Tainan Science-based Industrial Park (km.)	1,550 residential property transactions in 2007
Wang (2010), Shanghai, China	Urban rapid transit	Residential property were located	Sale price of residential property	Multiyear, (2000 to 2008 period)	Semi-log (hedonic regression)	- Distance to CBD - Distance to the sub-CBD	875 obs., during 2000 – 2008 period

Table 2.2 (Continued)

Sources	Type of Transport	Property Type	Measure of Property Value	Data Type	Functional Forms and Econometric Issues	Measure of Accessibility	Number of Observation
		within 4 km of rapid transit				- Distance to the nearest rapid transit system station	
Cervero and Kang (2011), Seoul, Korea	Bus rapid transit	Land parcel for residential and non-residential properties	Assessed land value	Multiyear, - 2001-2004 (pre-BRT) - 2005 -2007 (post-BRT)	Double-log for correcting heteroscedasticity problem (hedonic regression)	- Straight–line distance to the nearest BRT stops - Straight–line distance to the nearest major roads - Straight–line distance to the nearest subway station - Straight–line distance to the Han River (Note: the distance from each parcel to these points were calculated by using GIS maps)	For non-residential land-parcel; - 37,515 obs. for pre-BRT - 23,969 obs. for post-BRT For residential land-parcel; - 85,124 obs. for pre-BRT - 41,302 obs. for post-BRT

2.3 The Concept of Value Capture and Public Infrastructure Financing

Recent trends in many countries, especially in developed countries, take a particular interest in the “Value Capture” mechanism to finance public infrastructure investment, such as a transit station, highway, etc., in order to reduce government expenditure including the reduce burden on taxpayers of the whole country. Batt (2001: 1) states that “….value capture is a means by which to finance capital infrastructure, particularly transportation services, in a way that allows for efficient economic performance, simple administration, financial justice, and social facility..”. Several works suggest that public transportation should be funded by beneficiaries whose property is located adjacent to the transportation project by capturing a portion of the windfall gains that they received from the public investment. The study of Batt (2001) shows that the value capture mechanism was used to finance the construction of New York State Interstate Highway System, a nine mile stretch of I-87 known as the Northway by taking a portion of the windfall gains from landowners who benefit from the highway. The researcher indicate that the value of land generated from the Northway, within two miles on either side of the highway, totaled $3.734 billion, while the right of way and cost of construction of the nine mile stretch was only $128 million (value expressed in current dollars).

The value capture concept has also been used in several other countries, such as United State, Brazil, Colombia, Uruguay, Hong Kong, and Singapore, and in various types of public transportation projects. One obvious example is found in the United State. In 1894, the District of Columbia passed a law affecting property owners whose property was locate in front of a paved street. The property owner was required to contribute 50 percent of the first-time paving cost of streets, gutters, curbs, and side-walk through a special assessment. However, the Washington D.C. city council did not use this concept to finance the region’s transportation network because of an increase in federal grants in the years following World War II (Rybeck, 2004). Presently, the U.S. has a funding program for transport systems (e.g. streets, transit, and highway) that consists of a joint effort of federal, state, and local government with user fees and taxation as primary means to fund projects, including supplement method such as bounds, loans, concession, and public-private partnership (Lari et.al, 2009).

2.3.1 Type of Value Capture

If private owner gains are generated from a public project, a portion of those gains should be captured and returned to the public budget; this action is viewed by the taxpayer as fair and equitable and creates equality. Henry George, who introduced the "single land tax" concept (Brown and Smolka, 1997) stated that land value uplift can be generated by a community or private exertion and the uplift raises the wealth of the landowner or community. Therefore, it is reasonable to capture the increased value from landowner who receives advantage from a public project and bring the money back to the community as a whole. For instance, if the local government builds a new road in the community, residents in that area will receive a benefit from reaching the desired direction more quickly which can help the residents save time and travel cost. For this reason, the demand to hold lands surrounding the new road is possible to be expansion and positively affect the price of lands. In order to make it fair to the whole community, the local government should impose the capture mechanism such as land taxation to take an increment value from the landowners.

The logic of land value capture is demonstrated below (Table 2.3).

Table 2.3 Type of Land Value Capture

Increase in Land Value Generated by	**Increase in Land Value Captured by**	
	Community	**Private Owners**
Community	(1) Preservation of beaches and other lands/parks accessible to the general public Planned cities like New Town in the United Kingdom	(2) Public investments in highway or utilities Provision of high-quality urban services such as schools Change in zoning
Private Owners	(3) Beautification of large private garden Pollution (negative increment)	(4) Well-designed community or shopping center Gated community

Source: Brown and Smolka, 1997.

2.3.2 The Feature of Value Capture Strategies

As mentioned above, landowners realize positive changes in property values generated from public transportation, such as, railway station, highway, and commuter rail station. For this reason, public policy makers in various countries attempt to use the value capture strategy to reclaim a portion of this value for the purpose of funding public investments. Value capture is capital infrastructure investment financed through means of capturing either some or all of the added value of real property that results directly from that investment (Batt, 2001). Generally, the land value capture strategy has two important approaches. The first approach is used to recover the costs of infrastructure investment while the other is intended to capture some part of the unearned increment in private land values capitalized from public action (Walters, 2012). However, much of current empirical literature on land value capture field, such as Stopher (1993), Sullivan, Johnson and Soden (2002)**,** Ubbels and Nijkamp (2002), Rybeck (2004), Dye and Merriman (2006), and Lari et.al (2009), concentrates on how to finance the investment costs of public infrastructure through two groups of value capture mechanism; (a) taxes and fees and (b) non-tax value capture mechanism. Most of the value capture strategies fall under five categories which include taxes and fees, and non-tax mechanism as follow; 1) Land-Value Taxes, 2) Tax Increment Financing, 3) Special Assessment, 4) Development Impact Fees, and (v) Joint Development. The features of each strategy are described below (A summary of the feature are shown in Table 2.4).

2.3.2.1 Land-Value Taxes (LVTs) (or split-rate property taxes)

Lari et.al (2009) described the feature of Land-Value Taxes (LTVs) which are the most general type of value capture strategy. The land value taxes are utilized to capture the value that is created by the preparation of public infrastructure such as transportation network. The conventional methods of local public finance rely on the property tax, which is imposed on both land and any improvements, including buildings. In economic theory, a tax on land will be more preferable than improvement because it would be less of distortion. Because the supply of land is fixed, an additional tax might increase the price of land, but it will not affect on the supply. On the other hand, an additional tax on building may discourage the supply of building since its supply is not perfectly inelastic like land. In some countries such as

Canada, Australia, and New Zealand they impose the LTV in form of "split-rate" property tax on land and improvements at different rates, most often with a higher rate on land. However, unlike a tax increment financing (TIF) and special assessment (SA), it is not necessary to set the target area to apply the LVT to a specific project.

In addition, evidence from Taiwan (Lam and Tsui, 1998) has shown another type of land taxation, which is called Land Value Increment Tax (LVIT). The tax is levied on realized gains from land when a transaction has occurred. This strategy aims at eliminating unearned gains that are capitalized from land value increase. Basically, the concept behind the LVIT is similar to capital gains tax (CGT) in most countries. The difference between LVIT and CGT is that the CGT is mostly imposed by central government while the LVIT is levied by local government. The formula to calculate the net increment introduced by Lam and Tsui (1998) is:

Land value increment = Declared present value at the transfer – (the assessed value at the last transfer x consumer price index adjustment) – (land improvement costs + construction benefits fee paid + fee paid for land consolidation)

(1)

It should be noted that the LVIT is levied just once when the transaction or transfer has taken place. Thus, the Land Value Increment Tax is different from the Land-Value Taxes (LVTs) which has been mentioned before. However, if policymakers desire to use the Land Value Increment Tax to refinance the public project, in this case, the tax rate might be much higher than the Land-Value Tax because the LVT is levied annually (Coleman and Grimes, 2010).

2.3.2.2 Tax Increment Financing (TIF)

A Tax Increment Financing (TIF) is a public mechanism to capture the incremental value in property that is located within a designated area by using taxation. Dye and Merriman (2006: 2) stated that "the designation for tax increment district usually requires an area which is "blighted" or "underdeveloped" and the development would not be taken place "but for" the public expenditure or subsidy". The amount of tax increment could be generated over time and sufficient to pay for a new public transportation, including infrastructure improvement (Reconnecting

America's Center for Transit-Oriented Development, 2008). Reconnecting America's Center for Transit-Oriented Development (2008: 24) state that "….the tax increment financing can either be used on "pay as you go" basis overtime, or can be bonded against to provide up-front source of revenue…". The tax increment financing is more often used by local units of government to encourage economic development, housing, and redevelopment projects in targeted area (Lari et.al, 2009). For example, in the Colombia Despaz, the revenue from land value increment tax in the zoning area was about $8.341 billion (Otoya and Loaiza, 2000). In Portland, the TIF district has generated around $7.5 million to fund the Central City Streetcar (Lari et.al, 2009). Expenditures for a TIF district frequently come from debt financing in expected future tax revenue (Dye and Merriman, 2006) though the bond issuing, such as, tax increment financing bond, and general obligation bond. In the case of TIF, the local government does not necessary impose an additional special tax on property owners but only uses existing property tax. In addition, the municipality does not require an approval by the voters before implement the TIF district because the municipal does not add a new special charge on land owners unlike the Special Assessment (SA).

The basic rule of TIF was introduced by Dye and Merriman (2006) and it is illustrated in Figure 2.2. Suppose the policymakers in one municipality wish to design a TIF district in the blighted area. The area which is on the left hand side of the municipal border is established as a TIF district while the lower diagram is representing the base-year assessed value in the TIF area (portion B) and the non-TIF area (portion N). Since the TIF was designed, assessed values of properties in the municipality have increased to the portion I (which applies to the increment in the TIF area) and portion G which referred to the growth in non-TIF area. Generally, the assessed property value (portion B), or tax base, in the TIF boundary will be frozen in the year the district was created and remain frozen until the collected tax revenue are sufficient to cover the cost of construction. The model of Tax Increment Financing can be summarized as follows:

Before TIF, local government tax base	= B + N
After TIF, local government tax base	= B + N + I + G
After TIF, tax base available to local government	= B + N + G and;
TIF district authority's tax base	= I

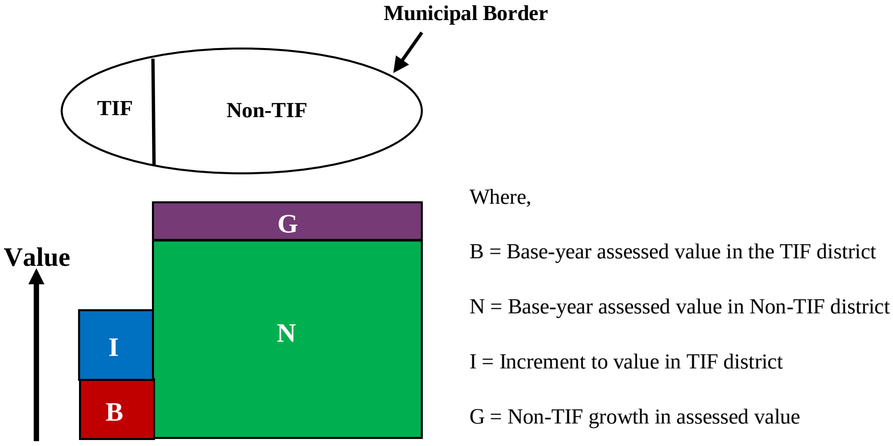


Figure 2.2 TIF and Non-TIF District and Value Components

Source: Dye and Merriman, 2006.

2.3.2.3 Special Assessment (SA)

A Special Assessment, sometimes referred to as Special Assessment District (SAD), Benefit Assessment District (BAD), Local Improvement District (LID), Betterment Tax or Betterment Levy[1] is an area in which a special charge (or betterment tax) is imposed to property owners who received windfall gains from public project based on geographic proximity to a public facility (Reconnecting America's Center for Transit-Oriented Development, 2008). The first use of special assessments in the United States occurred in New York City in 1961. It was established to fund the construction of street pavement and drainage system projects. (Zhao and Larson, 2012). Special assessment is used mostly in funding a public investment such as roads, police stations, sewer districts, fire protections, etc. The concept behind SA is that the land owners whose properties are located near a public facility will receive property value appreciation because of the public project; therefore, they should be charged for this benefit (Lari et.al, 2009). However, it should be noted that the amount of the assessment must be related to the cost of the investment, including the expected benefit to the property owner.

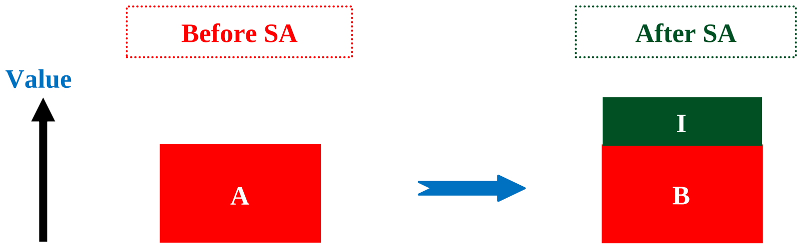
[1] betterment tax or betterment levy as known in United Kingdom

The concept of betterment taxes or special charges within a special assessment district has two aspects; 1) the first aspect is that they are applied only on the incremental value resulting from the public infrastructure improvement, which differs from annual property taxes (Walters, 2012), 2) the second aspect is an additional special tax or assessment on the incremental value of property that is usually paid by property owners located within a special assessment district. For example, commercial and industrial property owners in Tysons Corner, Washington, D.C., were charged an additional 22 cents per $100 of assessed value in order to finance an expansion of the Dulles Metrorail (Metropolitan Planning Council, 2012).

Applying the example of Walters (2012: 12), we can calculate the betterment tax revenue as follows. Suppose a policymaker in town A wishes to capture 40 percent of the unearned increment value to recover a public investment; the property tax for all land is one percent of market value. If the market value of the land was $420 million in the previous year and land value increases to 5 percent per year due to the public investment in town A, the resulting total current year land values are $441 million, which includes increment value of $21 million and last year market value of $420 million. The total tax revenue will be calculated as follows:

Revenue from property tax = 1% × $420 million = $4.2 million
Revenue from betterment tax = 40% × $21 million = $8.4 million
Total Tax = $4.2 million + $8.4 million = $12.6 million

Thus, the policy maker can estimate how long the betterment tax should be imposed in order to recover the public investment cost. However, it should be noted, for simplification, the above referenced example does not factor in the inflation rate. When we consider forming a special assessment district by applying Figure 2.3, the market value of land before the construction of a public service has occurred in the target area, is represented by portion A. Since the SA district was designed, the market land value has increased to portion I, which refer to the incremental value of properties after setting special assessment district (note; portion A is equal to portion B).



Where,

A = Base-year market assessed value before setting SA district

B = Base-year market value after setting SA district

I = Incremental land value in SA district

Figure 2.3 Before and After Special Assessment and Value Components

The key characteristic of special assessment is that it requires at least a majority vote of affected property owners in order to be implemented (Reconnecting America's Center for Transit-Oriented Development, 2008). Normally, a special charge or betterment tax for 25-30 year period is usually imposed annually on properties within the assessment district (http://www.govincentives. com/ special.html). A betterment tax often ranges from 30 to 60 percent of the value increment (Walters, 2012).The SA might be used to fund both capital cost and ongoing operating costs through the issuance of bonds. For example, Seattle has established a "local improvements district (LID)" to finance a portion of the capital costs of a streetcar project (Lari et.al, 2009), the LID generated special assessment revenues of $25 million dollars which was a half of total cost of the streetcar line (Gihring, 2009). Los Angeles has developed a benefit assessment to finance the first construction phase of the Los Angeles Metro Rail project. The initial benefit assessment districts were set up to raise $130 million of the cost of the first 4.4 miles of this project (Stopher, 1993).

However, a special assessment district is more difficult to apply across a larger area, particularly across multiple municipalities, because a larger assessment district would not be able to receive sufficient funding. The different feature between special assessment district and tax increment financing is that SA is suitable for public transportation provided within single jurisdiction such as streetcar in the inner-city while the TIF has a wider boundary since the tax increment district can be set in the multiple areas that receive a windfall gain from public transportation rather than one municipality (Reconnecting America's Center for Transit-Oriented Development, 2008).

2.3.2.4 Development Impact Fees (DIF)

When the population of a community increases, the growth produces urban sprawl and demand for public services, including infrastructures and current inputs, such as roads, schools, recreation areas, and sewer services, etc., will increase over time. If a city maintains a constant level of public services, policymakers will be forced to make a decision on expanding public investments to serve the growing community. In addition, policymaker must determine how to finance the cost of infrastructures and current inputs. In the case of additional current public services, these costs can be charged to people who utilize them, which include new and existing residents, with a similar payment means that all residents in the city will be charged for current services. However, in the case of an incremental infrastructure investment, e.g., expanding a sewer service and recreation area, the cost could be financed by new residents when they move to the city (Brueckner, 2001). For instance, the dwellers in the new neighborhood could pay for the cost of constructing a new public park for their recreation facilities. One of funding choices for public infrastructure development is called "Impact Fees". The Washington State Legislature (2016) defines "Impact fees" as

> a payment of money imposed upon development as a condition of development approval to pay for public facilities needed to serve new growth and development, that is reasonably related to the new development that creates additional demand and need for public facilities, that is a proportionate share of the cost of the public facilities, and that is used for facilities that reasonably benefit the new development

Generally, impact fees are one-time charges for new residents, while existing residents are exempt because they paid this fee at a previous date when they were a new comer (Brueckner, 1997). The impact fees regularly impose on all type of development, for example, residential, industrial, retail, office building, and commercial (Burge, 2005). Typically, the fee is a variable rate depending on a land use and type of development. The purpose of the impact fees is to recover all or a portion of the cost of additional public infrastructure in new neighborhoods; for example, new roads, new parks, or new recreation facilities (Reconnecting America's Center for Transit-Oriented Development, 2008). However, impact fees can be imposed for off-site services such as, schools district, or local roads (Lari et.al, 2009). In 1981, San Francisco introduced a Transit Impact Development Fee (TIDF) to recover the increasing capital and operating costs of setting additional services to the downtown. Since impact fees are based on land use, the fee was in the range of $8 to $10 per gross square foot of new office building. The TIDF generated roughly $10 million of revenue annually (Reconnecting America's Center for Transit-Oriented Development, 2008).

2.3.2.5 Joint Development (JD)

Cervero (1994: 83-84) has defined the Joint Development (JD) as

> any formal, legally binding arrangement between a public entity and a private individual or organization that involves either private-sector payments to the public entity or private-sector sharing of capital or operating costs, in mutual recognition of the enhanced real estate development potential or higher land values created by setting of a public transit facility.

By this definition, a JD has three main characteristics: 1) a legal binding agreement between two or more parties 2) some form of revenue payments or cost-sharing from the private owner to the public sector, and 3) a willing approval to all terms and conditions by all parties. Therefore, it can be summarized that the joint development is a partnership developed between private sector and the local government public transport agency to develop real estate (Salon and Shewmake, 2010). The private sector can either construct the public facility or provide financial support to recover the facility costs (Lari et.al, 2009). For instance, the public transport agency can seek out a private developer to invest in some portion of infrastructure, such as a transit station, as a part of their real estate project. However, the developer is only interested in partnering on the most profitable segment of the project. If public sector seeking funds to extend transit service to areas with low development potential; the joint development mechanism might not be appropriate because no one will play this game (Salon and Shewmake, 2010). However, several cities, such as Hong Kong, Tokyo, Washington, D.C., and New York City, have adopted the idea of JD as a value capture strategy (Lari et.al, 2009). New York City incentivizes developers to restore subway station by using zoning incentives such as density bonuses (Cervero, 1994). In order to generate revenue for funding the capital to operate the rail service, the Washington, D.C.'s public transit agency (WMATA) has accomplished 24 projects which include 1,000 hotel rooms, and 4,000,000 square feet of an office space, under the joint development program. This program produced revenue to WMATA roughly $6 million per year (Covarrubias, 2004).

The study of Lari et.al (2009) has summarized the five value capture policies in eight aspects; contributor, coordination, timing, space, basis, cost, transport ownership, and level of government. For example, land value tax is usually imposed on landowners by the local taxing authority, since the timing of tax collection can occur before and/or after the transport improvement. The revenue generated from the LVT might be use to fund both capital and ongoing cost of the public transportation. Details about the other aspects of the value capture tools are shown in Table 2.4.

Table 2.4 Features of Value Capture Policies

Value Capture Strategies	Contributor		Coordination		Timing		Space			Basis		Cost		Transport Ownership		Level of Govt.	
	Landowners	Developer	Taxing Authority	Partnership	Before Transport Improvement	After Transport Improvement	On-site	Restricted Off-site Areas	Entire Jurisdiction	New Development	Old Development	Upfront (Capital)	Ongoing (O&M)	Public	Private	State	Local
Land Value Tax	√		√		√	√			√	√	√	√	√	√			√
Tax Increment Financing	√		√		√			√		√	√	√	√	√			√
Special Assessments	√		√		√			√		√	√	√	√	√		√	√
Development Impact Fees		√	√			√		√		√		√		√			√
Joint Development		√		√	√	√	√	√		√	√	√	√	√	√	√	√

Source: Lari et.al, 2009.

2.3.3 Case Studies of Applying Value Capture Mechanism

Table 2.5 shows the details of case studies on projects in several cities and countries that applied value capture mechanism to refinance public transportation investment, and eliminate the windfall gains from property owners. The value capture mechanism can be divided into two categories; taxes and fees, and non tax value capture tools. (Note: Walters (2012) indicated that tax increment financing (TIF) is a non-tax land value capture mechanism).

Table 2.5 Summary of Value Capture Mechanism Case Studies

Cities/ Country	Source	Details	Type of Value Capture	Note
Taxes and Fees Value Capture Tools				
Denmark	Walters (2012)	- Before 2004, when farmland was transferred to an urban zone legally, if land owners need to sell their land they will be required to pay for a special land development gains tax.	Special land development gains tax	- 50 % of increase in land value resulting from the change in zoning - One-time charges
Taiwan	Lam and Tsui (1998)	- Taiwan has imposed the Land Value Increment Tax (LVIT) on realized gains when a transaction occurs.	Land-Value Taxes	- The objective of the LVIT is to eliminate unearned gains from land owners. - One-time charge
Poland	Walters (2012)	- When landowners sell their land within 5 year period of changing farmland to an urban zone.	Land use charge	- 30 % of increase in land value resulting from the change in zoning - One-time charges
Portland, the US.	S. B. Friedman & Company (2010)	- The City of Portland has invested several new streetcar lines by using value capture strategies; special assessment and tax increment financing, funding part of 4 miles streetcar.	Special Assessment District and Tax Increment Financing	- The revenue generated from the value capture mechanisms were $41 million (or 40% of total investment cost), completed project - Annual charges
Singapore	Medda (2012)	- Land value capture mechanisms are the main source for funding transport infrastructure and services such as metro system.	Betterment tax	- A betterment tax is based on 50% of full market value.
Bogotá, Colombia	Peterson (2009)	- Between 1997-2007, Colombia imposed the betterment fees on all	Betterment Fees	- Funding 1/2 of street and bridge improvement. - Annual charges

Table 2.5 (Continued)

Cities/ Country	Source	Details	Type of Value Capture	Note
		Taxes and Fees Value Capture Tools		
		properties in Bogotá which affect by the Main Street and bridge improvement, in order to finance the construction projects. The tax revenue which generated from this program was amount US$ 1.1 billion.		
United Kingdom	Peterson (2009)	- UK imposes betterment levies on land value gain resulting from public investment to recover cost of constructions	Betterment tax	- 40% of incremental land value
San Francisco, the US.	Reconnecting America's Center for Transit Oriented development (2008)	- San Francisco introduced a transit Impact Development Fee (TIDF) in 1981, to recover the capital and operating cost of additional service.	Development Impact Fee	- The fee was range from $8 to $10 per gross square foot of new building depending on the land use. - One-time charge
Los Angeles, the US.	Covarrubias (2004)	- The City of Los Angeles started to construct a metro system in 1980's. - The City established two benefit assessment districts to finance the cost of construction of the first line.	Benefit Assessment District	- Properties located within 1/3 miles from the station were charged a part of increment land value. - The charge was set in per area of parcel of land, except for hotels, office space and retail, which were charged per floor area. - The charge had a cap of $0.42 per square foot

Table 2.5 (Continued)

Cities/ Country	Source	Details	Type of Value Capture	Note
		Taxes and Fees Value Capture Tools		
				- The charge was rank from 1985 to 2007. - Annual charges
Australia	Peterson (2009)	- Sydney, Australia imposed a betterment levy on the land owners whose gains resulting from planning authorization to convert land to urban use. Since, the increment values of land were estimated from a baseline of August 1969 to indicate which land was rezoned. - The revenue from betterment levy was used to fund infrastructure investment required for urban use such as water supply.	Betterment levy	- 30% tax rate on land value gains. - Annual charges
Washington D.C. , the US.	Metropolitan Planning Council (2012)	- The commercial and industrial property owners in Tysons Corner, Washington D.C., were collected a special charge for financing the Dulles Metrorail expansion.	Special Assessment	- The additional special charge is 22 cents per $100 of assessed value. - Annual tax - The revenue generated from this strategy was $25 million or 23% of total project cost (completed project). - Annual charges

Table 2.5 (Continued)

<table>
<tr><th>Cities/ Country</th><th>Source</th><th>Details</th><th>Type of Value Capture</th><th>Note</th></tr>
<tr><td colspan="5">Taxes and Fees Value Capture Tools</td></tr>
<tr><td>California, the US.</td><td>Lari, et.al (2009)</td><td>- Chula Vista, a municipality in California levied a development impact fee system in order to finance the construction of all new development including renovation of existing public infrastructures.</td><td>Development Impact Fee</td><td>Chula Vista, Impact Fee by Land Use
<table>
<tr><th>Land Use</th><th>Fee</th></tr>
<tr><td>Residential-Single-family dwellings</td><td>$7,891/DU</td></tr>
<tr><td>Residential-Multifamily dwellings</td><td>$7,477/DU</td></tr>
<tr><td>Commercial/Office</td><td>$25,181/acre</td></tr>
<tr><td>Industrial</td><td>$7,958/acre</td></tr>
<tr><td>Special land use</td><td>$25,181/acre</td></tr>
<tr><td>Olympic Training Center</td><td>$7,958/acre</td></tr>
<tr><td>Public purpose</td><td>Exempt</td></tr>
<tr><td>Nonprofit community purpose facility</td><td>Exempt</td></tr>
<tr><td>Special purpose project</td><td>$12,590/acre</td></tr>
</table>
Source: Chula Vista City Code 3.50.090</td></tr>
<tr><td>Ohio, the US.</td><td>Libby and Carrion (n.d.)</td><td>- In 1993, the City of Beavercreek in Greene County imposed an impact fee on a development of new land. The purpose of fee was for providing the new roads, streets, and traffic systems in the new development area.</td><td>Development Impact Fees</td><td>- One –time charges</td></tr>
</table>

Table 2.5 (Continued)

Cities/ Country	Source	Details	Type of Value Capture	Note
Non-Taxes and Fees Value Capture Tools				
Washington D.C. , the US.	Covarrubias (2004)	- In 1999, Washington D.C.'s public transit had 24 accomplished projects which include 1,000 hotel rooms, 4 million square feet of an office space, and 300 dwellers. The projects create revenue about $6 million per year .	Joint Development	The objective of this mechanism is to generate revenue for reclaiming the capital and operating cost of rail service.
Portland, the US.	Lari, et.al (2009)	- Portland created the TIF district to fund the Central City Streetcar	Tax Increment Financing	The TIF district generated revenue around $7.5 million.
Brazil	Covarrubias (2004)	- For reimbursement rail transit, Sao Paulo's metro has many joint development projects through building of bus terminals next to the station on land ranted to the metro, including three malls created on land owned by the metro.	Joint Development	In 2002, the bus terminal generated revenue amount R$8.7 million to the metro. While the revenue generated from one mall was more than R$1.3 million.
Dallas, Texas, the US.	S. B. Friedman & Company (2010)	- Tax increment financing will be used to finance basic infrastructure improvements at the transit-oriented developments, seven light rail stations in Dallas.	Tax Increment Financing	The TIF district generated revenue $182 million (net present value of the project).
Bangalore, India	Peterson (2009)	- In April 2008, the state of Karnataka completed construction of the new international airport in Bangalore, This airport	Joint Development	- Land were own by the state of Karnataka, but the private sector, led by Siemens, invest in the airport construction.

Table 2.5 (Continued)

Cities/ Country	Source	Details	Type of Value Capture	Note
Non-Taxes and Fees Value Capture Tools				
		are built by using public – private partnership or joint development program.		
Florida, the US	Zhao, Das, and Larson (2012)	- In 2006, the Florida Department of Transportation applied a joint development program, "Vision Plan", for funding a statewide high-speed rail system.	Joint Development	- The amount value of this program was $3.5 billion.
Hong Kong	Zhao, Das, and Larson (2012)	- The Metropolitan Transit Railway Corporation (MTRC) uses a "rail-property (R+P) model", or joint development method, to recovery cost of a railway construction. - The process of this strategy is the Hong Kong Government sells development rights to the MTRC at a "before rail" price, after that the MRTC sells the right to a selected developer at a "after rail" price. Margins from the transaction is use to finance the railway investment.	Joint Development	-

2.3.4 Case Study of Value Capture Mechanisms

In recent years, many researchers have been interested in value capture strategies in various aspects. Some work focuses on how to apply the value capture mechanism to their particular society. While, some work attempts to prove whether the mechanism was suitable for their country. Table 2.6 shows details about case studies of value capture mechanism in various aspects.

Table 2.6 Summary of Value Capture Mechanism Case Studies

Title	Authors (Date)	Source	Key Topic for Value Capture	Value Capture Tool	Catchment Area	Terms	Actual or Model?	Value Capture
Local Financial Dimensions of Tax Increment Financing: A Cost-Revenue Analysis	Huddleston (1982)	Public Budgeting & Finance	Developing conceptual framework of discounted cost-revenue analysis for conducting TIF project over time. This study is applied for both sponsor government and contributor government.	Tax Increment Financing	16 Wisconsin TIF projects	- The tax increment is generated by applying general property tax rate for the increment value of properties which located in TIF project. The increment value is referred as a surplus value which above the "base value". -A positive net present value stands for a profitable investment of TIF project.	Model	<u>**Sponsor government**</u> - Eight of 16 projects would face break even net present value within 20 years. - Four of sponsor government would face positive net present value within 30 years. <u>**Contributor government**</u> - Five of 16 projects would experience negative net present value over 30 year period. - The mean break even period of 11 projects is 23.0 years.
A Model of Tax Increment Financing Adoption Incentives	Dye and Sundberg (1998)	Growth and Change	The objective of this study is to offer an systematic framework for Tax Increment Financing (TIF) to investigate an efficiency and financial viability.	Tax Increment Financing (TIF)	-	- TIF can be applied to improve blighted areas in various municipalities. - TIF is most attractive to the local government which has high expected growth rates. - If the incremental tax revenue generated is at least a large as project cost, a TIF is financially viable - A TIF district is efficiency enhancement if the tax receipts generate positive cash flow that cover the opportunity costs and expected tax revenue.	Model	

Table 2.6 (Continued)

Title	Authors (Date)	Source	Key Topic for Value Capture	Value Capture Tool	Catchment Area	Terms	Actual or Model?	Value Capture
Value Capture as a Policy Tool in Transportation Economics: An Exploration in Public Finance in the Tradition of Henry George	Batt (2001)	American Journal of Economics and Sociology	- This study demonstrated an ability of value capture mechanism to finance a part of the New York State Interstate Highway System, a nine-mile stretch.	Value Capture Tax	New York	Methodology: 1) Specifying the land parcels which adjacent to the public investment. 2) Surveying the assessed and market value of the land parcels before the beginning of the project. 3) Acquiring the assessed and market value of the land parcels when the bonds will be issued. 4) Converting the both value in constant dollars 5) The appropriate level of value capture tax will be imposed after calculating the debt service of the infrastructure project	Actual	- The costs of construction the nine-mile stretch were $128 million (current dollars) while windfall gains of the adjacent properties which generated by this highway system equal to $3.7434 billion. - The study shows that the capital cost of construction can recovery by the windfall gains which fall to the private landholders.
Applying Value Capture in the Seattle Region	Gihring (2009)	Planning Practice & Research	- Focusing on Land Value Tax (LVT) scenario model - The two-rate LVT is 95% tax on land and 5% tax on improvement value	- Land Value Tax (LVT) - Bond issuing with difference mechanism such as LVT, an incremental gains tax.	City of Seattle	-	Model	-

Table 2.6 (Continued)

Title	Authors (Date)	Source	Key Topic for Value Capture	Value Capture Tool	Catchment Area	Terms	Actual or Model?	Value Capture
Tax Increment Financing (TIF) Best Practices Study	Sullivan, Johnson, and Soden (2002)	IPED Technical Reports	- The literature reviews of the TIF history, pertinent laws governing TIF program, and develop a set of best practices for policy maker who is fascinated in TIF financing program.	Tax Increment Financing (TIF)	-	- This study adopt a TIF model based on two performance criteria: financial viability and efficiency enhancement. - The TIF district is financial viability; if the additional tax revenue at least a large as its cost. - The TIF financing is efficiency enhancement; if incremental benefits exceed the tax revnue.	Model	-
Using value capture to finance infrastructure and encourage compact development	Rybeck (2004)	Public Works Management Policy	- Washington. D.C. purposes to use a value capture mechanism to finance part of a new infill Metrorail station. - The article compares a split-rate property tax with other methodologies, such as tax increment financing, for funding transport infrastructure investment.	A split-rate property tax	Washington. D.C.	- This article reviews a few studies about value capture mechanism briefly. - Comparison about using a split-rate property tax with other types of value captures strategies such as Special Assessment District, Tax Increment Financing .	-	-

Table 2.6 (Continued)

<table>
<thead>
<tr><th>Title</th><th>Authors (Date)</th><th>Source</th><th>Key Topic for Value Capture</th><th>Value Capture Tool</th><th>Catchment Area</th><th>Terms</th><th>Actual or Model?</th><th>Value Capture</th></tr>
</thead>
<tbody>
<tr>
<td rowspan="2">Betterment Levy in Colombia Relevance, Procedures, and Special Acceptability</td>
<td rowspan="2">Ochoa (2011)</td>
<td rowspan="2">Land Lines- Lincoln Institute of Land Policy</td>
<td>- The model of Bogotá set several factors stand for the benefit of the public projects such as increasing in mobility, general urban planning benefits, changes generated in land use, increasing in market price of adjacent properties, integration of the public project into the urban structure, optimization of flowing and mobility, and recovery of depressed areas , in order to assess the levy, but do not evaluate the value added of the properties. Since, the Bogotá model is similar to general tax to finance public investment.</td>
<td>Betterment Levy (or Special Assessment)</td>
<td>Bogotá</td>
<td>Colombia impose the betterment levy on all properties in Bogotá which affect by the main road projects, in order to finance the construction projects</td>
<td>Actual</td>
<td>
<table>
<tr><th colspan="4">Betterment Levy Collections</th></tr>
<tr><td>Projects</td><td>Approval date</td><td>Collection date</td><td>Amount (US$ million)</td></tr>
<tr><td>General betterment</td><td>1993</td><td>1993</td><td>106.2</td></tr>
<tr><td>Build the city (phase 1)</td><td>1995</td><td>1996-1998</td><td>351.9</td></tr>
<tr><td>Build the city (phase 2)</td><td>2001</td><td>2002</td><td>55.9</td></tr>
<tr><td>Agreement 180 local betterment phase 1</td><td>2005</td><td>2007-2010</td><td>260.2</td></tr>
<tr><td>Local betterment phase 2</td><td>2005</td><td>2009</td><td>265.7</td></tr>
<tr><td>Local betterment phase 3</td><td>2005</td><td>2012</td><td>262.1</td></tr>
<tr><td>Local betterment phase 4</td><td>2005</td><td>2015</td><td>85.5</td></tr>
</table>
</td>
</tr>
<tr>
<td>- Manizales uses a “duo appraisal” to evaluate the benefit of public projects. The 1st method is creating a land price map before the construction occurs. The 2nd method is determine value added of properties which generated from the new project in the area. Since the project finish, the authority</td>
<td>Betterment levy</td>
<td>Manizales</td>
<td>The city use betterment levy to finance road development and urban renovation.</td>
<td>Actual</td>
<td>
<table>
<tr><th colspan="2">Projects Financed with Betterment Levies</th></tr>
<tr><td>Total amount assessed</td><td>US$ 24.6 million</td></tr>
<tr><td>Number of lots</td><td>69,466</td></tr>
<tr><td>Number of payment in advance</td><td>52,089 (75% of the total)</td></tr>
<tr><td>Total expected revenue</td><td>US$ 21.9 million</td></tr>
<tr><td>Actual amount collected</td><td>US$ 17.2 million (79% of the amount expected)</td></tr>
</table>
</td>
</tr>
</tbody>
</table>

Table 2.6 (Continued)

Title	Authors (Date)	Source	Key Topic for Value Capture	Value Capture Tool	Catchment Area	Terms	Actual or Model?	Value Capture
			will compare the value added of properties before and after construction and then use to set the betterment levy.					
Capturing the Value of Transit	Reconnecting America's Center for Transit-Oriented Development (2008)	Center for Transit-Oriented Development	This paper attempt to study in four areas; (1) summarizing evidences of the previous studies in impact of transit system to the value of adjacent property (2) Giving a discussion of the role of the developers and property owners in value capture mechanisms. (3) Present the currently value capture tools to finance the capital cost of transit, and (4) providing a value capture framework.	Special Assessment, Tax Increment Financing, Joint Development, and Development Impact Fees	-	- This study describes the four types of value captures strategies to refinance the transit system, and explore where there have been used. The strategies include (1) Special Assessment, (2) Tax Increment Financing, (3) Joint Development, and (4) Development Impact Fees.	-	-
Opportunities for Value Capture to Fund Public Transport: A Comprehensive review of the Literature with a	Salon and Shewmake (2010)	Report prepared for the Asian Development Bank	- This report attempt to use the finding from value capture's literatures to create value capture strategies for financing a public transport system in East Asian cities.	-	East Asian cities.	- The study reviews in three feature of related literatures in order to create a value capture mechanism; (1) the impact of public transportation on land development, (2) estimating the land value increase generated by	-	-

Table 2.6 (Continued)

Title	Authors (Date)	Source	Key Topic for Value Capture	Value Capture Tool	Catchment Area	Terms	Actual or Model?	Value Capture
Focus of East Asia						the public transport, and (3) case studies of the use of value capture tools to fund public transport.		
Special Assessments as a Value Capture Strategy for Public Transit Finance	Zhao and Larson (2011)	Public Works Management Policy	- The historical review of special assessments, the scope of use, and the value capture strategies for reimbursement cost of public construction, particularly transit system. - Evaluating the special assessment in financing transit project based on 4 criteria: efficiency, equality, sustainability, and feasibility.	Special assessment	-	-	-	-

CHAPTER 3

METHODOLOGY

3.1 Theoretical Concept

Home and land price is not only determined by their attributes, but also have other important factors that influence the price such as the quality of the environmental surrounding the residential property, the ease of travelling to and from desired destinations or accessibility, etc. Therefore, the accessibility to public transportation system is an importance factor in determining properties value. In this step, we need to find the relationship between transportation improvement and the change in property value for properties located in an urban area; this is referred to as "value creation".

The impact of a transportation system on property price has been tested by many researchers using various techniques. However, one of the most popular techniques is the “Hedonic Price Method” (HPM). Environmental economists use the hedonic pricing method because it relies on market transaction for differentiated characteristics of a product which is sold in one market, such as cars, computers, and houses (Taylor, 2003)

3.1.1 Modeling Approach

3.1.1.1 Hedonic Price Model

Rosen (1974: 34) stated that “…hedonic prices are defined as the implicit price of attributes that are revealed to economic agent from observed prices of differentiated products and the specific amounts of characteristic associated with them…” Theoretically, the hedonic price method consists of two steps which are referred as a first-stage and second-stage analysis. The first-stage analysis is used to estimate the implicit prices of any attribute of a product by using regression analysis, while the second-stage is used to estimate the demand function for the characteristics of the commodity (Taylor, 2003).

1) Market Equilibrium

Considers markets which have a differentiated product that is explained by n attributes, $\underline{z} = (z_1, z_2, z_3, ..., z_n)$, assuming, the differentiated good is sold in a perfectly competitive market. Therefore, the equilibrium price of this product is determined by the interactions of many producers and consumers, *P(Z)*.

(1) The Consumption Decision

The first condition for hedonic price method is that the market contains of many consumer who desire to maximize their utility. Suppose consumers purchase one unit of a product with a particular value of attribute $\underline{z}$, assuming the utility function is strictly concave, the utility of each consumer, j, is defined as:

$$U^j = \left(x, z_1, z_2, z_3, ..., z_n, \alpha^j\right) \tag{3.1}$$

Where, x is a composite goods that represents all the other goods, z_i represents a differentiated commodity, and α^j is a consumer parameter or shift factor, then α is a parameter that differs from person to person.

Subject to

$$y^j = x + p(z) \tag{3.2}$$

Since, y^j is the income of consumer j, and x is the total expenditure on all other goods; where the price of x is equal to 1. Assume that consumers are reasonable when purchasing a commodity. In order to get the maximize utility, the consumer will chooses an amount of z and x to purchase subject to his budget constraint.

So, the first order condition is;

$$\frac{\partial P}{\partial z_i} = \frac{\partial U / \partial z_i}{\partial U / \partial x} = MRS_{z_i x} \tag{3.3}$$

The equation (3.3) indicates that the marginal rate of substitution between any attribute, z_i, and the composite goods, x, is equal to the ratio of the implicit price for z, and the price of x (which is equal to 1).

We also have to the bid function θ, which describes the relationship between the money bid consumer j will make for z when one or more of its component attributes are changed while the utility and income remain constant. So, we can use the equation (3.3) to define the bid function by accepting that income less the bid a consumer makes for Z attribute is the amount of money left over to spend on the composite good, x. Therefore, the bid function is:

$$u(y-\theta, \underline{z}, \alpha) = \overline{u_0} = \theta_j = \theta(\underline{z} = y_0, \overline{u_j}, \alpha) \quad (3.4)$$

θ_j is the bid function and is defined as the amount of money that consumer j is willing to pay for $\underline{z}$ and $y - \theta$ represents all other goods at a given utility index and income. Thus, the bid function, θ, for one attribute depends on $\underline{z}$, y_o, u_j, and α. Alternately, θ_j, is the marginal rate of substitution between z_i and money of consumer j, or the implicit marginal valuation for consumer j point on z_i at a fixed utility index and income. Therefore the amount that consumer j is willing to pay for $\underline{z}$ at a given utility and income is shown by θ ($\underline{z}$; u, y) whereas P(Z) is the minimum price that individual is willing to pay in the market. The bid function behaves according to the law of "Diminishing Marginal Utility", so the bid function is increasing in z_i at a decreasing rate. As the attribute z_i, such as the square feet of living space in a house, increases, the price of house will go up at a decreasing rate (Figure 3.1).

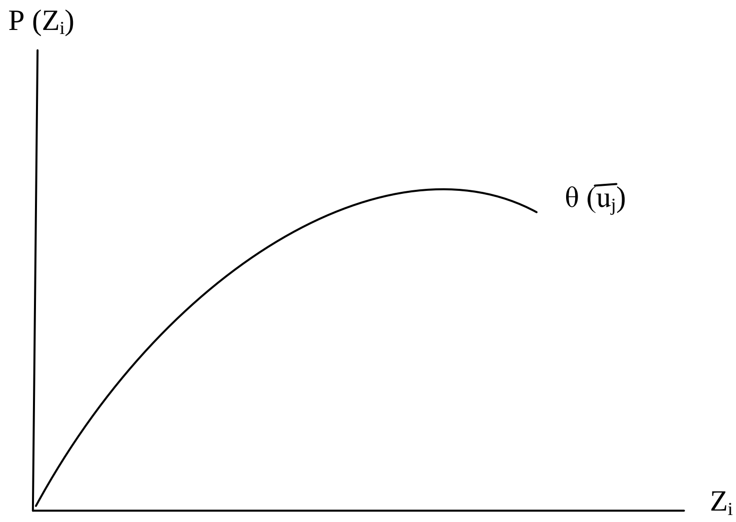


Figure 3.1 The Bid Function

(2) The Production Decision

For the supply-side of the market, we can explain that the producer with characteristic k seeks for a maximize profits, π, so the profit maximization for the producer k is;

$$\pi = H * P(\underline{z}) - C\left(H, \underline{z}, \delta^k\right) \tag{3.5}$$

Where, H is the number of units of housing, Z, P ($\underline{z}$) is the price of house that the firm produces, and δ^k represents firm's characteristics. The total cost of production is represented by C (H, $\underline{z}$, δ^k); it assume that C is convex with C (0, $\underline{z}$) = 0 and C_H and C_{zi} >0. Therefore, the marginal costs of producing more units of housing are positive and increasing.

As we known, the price of goods in competitive market is an exogenous; that is, no single firm can affect the price. To simplify, assume that the firm produces only one model of Z, and there are no cost spillovers form plant to plant and each firm is acting independently from others. Suppose the producer chooses what kind of Z to produce, Z^k, and then chooses the amount of that type to produce in order to receive the maximize profits. The behavior of the producer in a differentiated goods market is described by an offer function, $\varphi^k = \varphi$ ($\underline{z}$; H, π_0, δ^k), which describes the amount of money that a producer is willing to accept for any attribute of Z, holding constant the number of houses that a firm produces, H, and it's level of profit, π_0. Since the offer function is defined by equation (3.5). At the optimum, the marginal price that the firm is willing to accept for z_i, φ_{zi}, equals to the marginal cost of the producing characteristic per unit of the differentiated good, C_{zi} / H. It should be noted that the offer function behaves according to the law of "Diminishing of Marginal Product", because the price of the house will go up as the living space of the house is increased. Thus, it takes the shape of an offer function and the slope is convex as shown in the Figure 3.2.

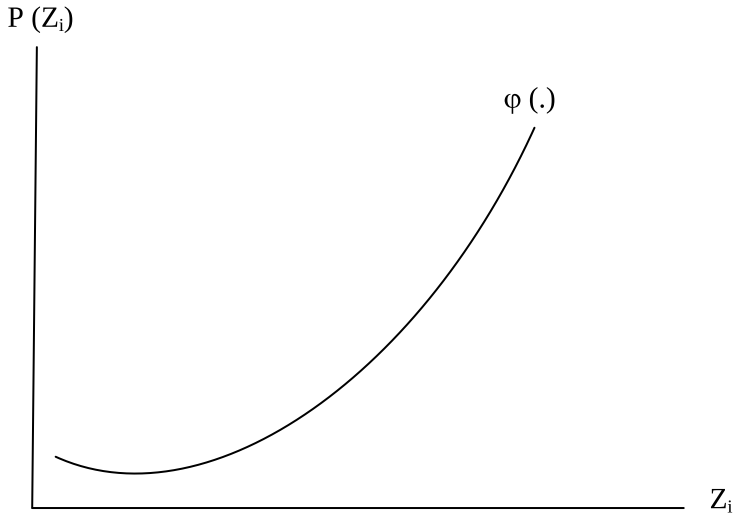


Figure 3.2 The Offer Function

(3) Market Equilibrium

An analysis of the consumer and producer decisions is on the assumption of market equilibrium. Therefore, it is necessary to find the equilibrium price function Rosen (1974) At the market equilibrium, a seller and buyer are perfectly matched when the offer function tangent to the bid function, P ($_z$), which makes market demand equal to market supply.

Figure 3.3 describes the equilibrium price schedule, P ($\underline{z}$), that varies with changes in z_1 by holding all of the other attributes constant. Thus, P ($\underline{z}$) is the total price paid for z_1 and increases at a decreasing rate. Suppose z_1 is the number of bedrooms in a house. So, we might expect that a house with 3 bedrooms will be more expensive than a house with 2 bedrooms.

From the demand side, there is a bid functions for two consumers, θ_1 and θ_2. For any bid function, only the level of z_1 can change, but the level of other things, such as income, utility, and all other attributes, are held constant. A higher level of consumer utility is shown by a bid function curve that gets closer to the horizontal axis. Therefore, it can be implied that a higher bid for the same level of z_1 represents a lower level of utility because consumer has less money left to spend on the other goods, x. The optimum choice of z_1 for any consumers is the point at which their bid function is tangent to the equilibrium price schedule. For consumer 1, the optimum choice occurs at $z^{1*}{}_1$ and the consumer pays a total price of P ($z^{1*}{}_1$). For consumer 2, it occurs at $z^{2*}{}_2$ and a total bid price of P ($z^{2*}{}_2$). At the optimum choice of z_1, the marginal bid ($\partial\theta/\partial z_1$) is always equal to the marginal price ($\partial P(\underline{z})/\partial z_1$), for each consumer.

From the supply side, the offer functions for two producers is denoted by φ_1 and φ_2. The higher level of total profits is represented by the offer function which is further away from the horizontal axis. For producer 1, the optimum choice of z_1 is to produce in each of H units of differentiated goods is at $z^{1*}{}_1$ and total offer price of P ($z^{1*}{}_1$). For producer 2, it occurs at quantity at $z^{2*}{}_2$ and a total offer price of P ($z^{2*}{}_2$).

Therefore, we can draw the hedonic price function of attribute Z which occurs at the point where equilibrium interaction between all sellers and all buyers of a differentiated good occurs (Figure 3.3). At the equilibrium, the marginal price is equal to the marginal WTP (willingness to pay) for attribute of Z by consumers, $\partial\theta/\partial z_i$.

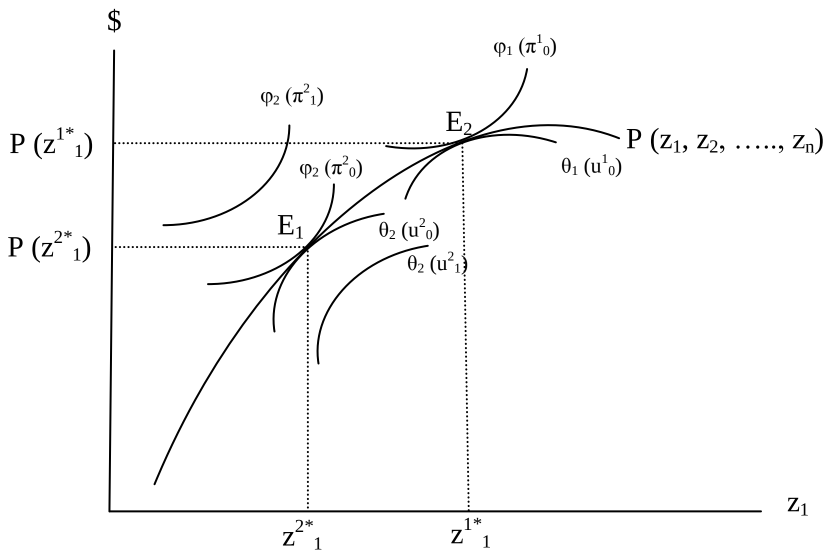


Figure 3.3 The Hedonic Price Function

2) Hedonic Price Function

$$P(z_i) = f\left(z_1, z_2, \ldots\ldots\ldots\ldots\ldots\ldots, z_n\right) \qquad (3.6)$$

In this case, we assume that the hedonic price function is a simple linear function, therefore the equation is;

$$P = \alpha_0 + \sum_{i=1}^{h} \beta_i H_i + \sum_{j=1}^{n} \beta_j N_j + \sum_{k=1}^{L} \beta_k L_k + \varepsilon \qquad (3.7)$$

Where, P is home sale price or rental price, H is the structural or housing attributes (e.g. number of bedroom, number of bathroom, lot size, age of house etc.), N represents neighborhood characteristics, such as quality of schools, or ambient air quality, and L represents location characteristic; for example, proximity to the central business district, distance to a transit station, including proximity to environmental amenities and disadvantages.

3.1.1.2 Functional From for the Hedonic Price Function

The purpose of this study is to estimate the impact of public infrastructure on the property value, by using the hedonic price methods. The hedonic price functions are normally reduced form equations for both demand and supply sides. When the housing market is in equilibrium, the hedonic price function is a price schedule for the housing attributes, and the partial derivatives of the hedonic price function with respect to an individual attribute (z_i) stands for the implicit price of any attribute (Garrod and Willis, 1999). The most popular functional forms are log-linear, semi-logarithmic and linear Box-Cox functional form (Anderson, Shyr, and Fu, 2010). The summary of functional form and the value of implicit price are shown in Table 3.1.

Table 3.1 Functional From for the Hedonic Price Function

Name	Equation	Implicit Prices
Linear:	$P = \alpha_0 + \sum \beta_i z_i$	$\partial P / \partial z_i = \beta_i$
Semi-Log:	$\ln P = \alpha_0 + \sum \beta_i z_i$	$\partial P / \partial z_i = \beta_i \times P$
Double-Log:	$\ln P = \alpha_0 + \sum \beta_i \ln z_i$	$\partial P / \partial z_i = \beta_i \times P / z_i$
Quadratic:	$P = \alpha_0 + \sum_{i=1}^{N} \beta_i z_i + \frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} \delta_{ij} z_i z_j$	$\partial P / \partial z_i = \beta_i + \frac{1}{2} \sum_{j \neq i} \delta_{ij} z_j + \delta_{ji} z_i$
Quadratic Box-Cox:	$P^{(\theta)} = \alpha_0 + \sum_{i=1}^{N} \beta_i z_i^{(\lambda)} + \frac{1}{2} \sum_{i,j=1}^{N} \delta_{ij} z_i^{(\lambda)} z_j^{(\lambda)}$	$\partial P / \partial z_i = \left[\beta_i z_i^{\lambda-1} + \sum_{j=1}^{N} \delta_{ij} z_i^{\lambda-1} z_j^{(\lambda)} \right] P^{1-\theta}$

Source: Taylor, 2003.

In hedonic analysis, the Box-Cox regression has been an especially popular technique of searching for a suitable functional form based on goodness of fit (Williams, 2008). The Box – Cox transformation can obtain the residuals more closely to normality with less heteroskedasticity problems. The strength of the Box-Cox function is that it can be used as a testing functional form and as a form within itself

(Williams, 2008: 37). Moreover, the Box – Cox transformation is more flexible functional form including provide an accurate estimate result versus other functional forms. From the work of Cropper, Deck and McConnell (1988) it was found that the linear Box-Cox functional from was better for hedonic research than the linear, semi-log, double-log, quadratic, and quadratic Box-Cox function. For $Y^{(\lambda)}$, the general linear Box-Cox transformation on a single variable is defined as:

$$Y^{(\lambda)} = \frac{Y^{\lambda} - 1}{\lambda} \quad \text{for} \quad \lambda \neq 0 \quad \text{or}$$
$$Y^{(\lambda)} = \ln Y \quad \text{for} \quad \lambda = 0 \qquad (3.8)$$

However, the complex version transforms both sides of the equation with a difference parameter, since θ stands for the Box-Cox transformation parameter on the dependent variable, and λ denotes for the Box-Cox transformation parameter on the independent variable

$$\frac{Y^{\theta} - 1}{\theta} = \alpha + \sum_{i=1}^{K} \beta_i \frac{X_i^{\lambda} - 1}{\lambda} + \sum_{s=1}^{J} \gamma_s D_s + \varepsilon \text{ for } \theta \text{ and } \lambda \neq 0. \qquad (3.9)$$

Where, $\varepsilon \sim N(0,\sigma^2)$; the equation (3.9) is referred as an unrestricted Box-Cox (UBC) model. While, a restricted Box-Cox (RBC) model transform both sides of the equation with the same parameter, excluding the dummy variables (D_s). It should be noted that the RBC model will be equal to the UBC model if θ =λ. The restricted Box-Cox model can be written as;

$$\frac{Y^{\lambda} - 1}{\lambda} = \alpha + \sum_{i=1}^{K} \beta_i \frac{X_i^{\lambda} - 1}{\lambda} + \sum_{s=1}^{J} \gamma_s D_s + \varepsilon \quad \text{for } \lambda \neq 0 \quad \text{or}$$
$$\ln Y = \alpha + \sum_{i=1}^{K} \beta_i \ln X_i + \sum_{s=1}^{J} \gamma_s D_s + \varepsilon \quad \text{for } \lambda = 0 \qquad (3.10)$$

For a left-hand Box-Cox (LHBC) model is transformed only on the dependent variable:

$$\frac{Y^{\lambda}-1}{\lambda}=\alpha+\sum_{i=1}^{K}\beta_i X_i+\sum_{s=1}^{J}\gamma_s D_s+\varepsilon \quad \text{for } \lambda \neq 0 \quad \text{or}$$

$$\ln Y=\alpha+\sum_{i=1}^{K}\beta_i X_i+\sum_{s=1}^{J}\gamma_s D_s+\varepsilon \quad \text{for } \lambda = 0 \tag{3.11}$$

The last equation is a right-hand Box-Cox (RHBC) model which is transformed only on the independent variable, excluding the dummy variables:

$$Y=\alpha+\sum_{i=1}^{K}\beta_i \frac{X_i^{\lambda}-1}{\lambda}+\sum_{s=1}^{J}\gamma_s D_s+\varepsilon \quad \text{for } \lambda \neq 0 \quad \text{or}$$

$$Y=\alpha+\sum_{i=1}^{K}\beta_i \ln X_i+\sum_{s=1}^{J}\gamma_s D_s+\varepsilon \quad \text{for } \lambda = 0 \tag{3.12}$$

The RBC model represents a linear model if the transformation parameter is equal to 1 (λ = 1), and the RBC is a double-log equation when the transformation parameter equals to 0 (λ = 0). The RHBC model stands for a linear model if λ = 1, and RHBC is a right-hand side semi-log model when λ = 0. Furthermore, the RBC model is equivalent to a reciprocal functional from if λ = -1. While, the LHBC represents to a linear functional form if λ = 1, and the LHBC is a left-hand side semi-log model when λ = 0. However, the most general form of Box-Cox transformation, the UBC model, can be represented all of model (a RBC, LHBC, and RHBC) depending upon the transformation parameter which provide by the statistic software.

The estimated Box-Cox model from equation (3.9), (3.10), (3.11), and (3.12) can be applied to explore implicit prices (or economic rent) of any housing characteristic. The equation (3.9) which represent to the UBC model, the implicit price is calculated by taking the partial derivative of the market sale price, Y, with respect to X_i:

$$\frac{\partial Y}{\partial X_i}=\beta_i X_i^{\lambda-1} Y^{1-\theta} \tag{3.13}$$

The implicit price for dummy variables is calculated by taking the partial derivative of the market sale price with respect to D_s;

$$\frac{\partial Y}{\partial D_s} = \gamma_s Y^{1-\theta} \tag{3.14}$$

These formulas can be adopt for the RBC model by replace the transformation parameter $\lambda = \theta$.

3.2 Applying a Property Value Capture Taxation for Refinance a Public Investment

3.2.1 Property Value Capture Modeling

This section has adopted some portion of the TIF model which was developed by Brueckner (2001) in order to create a value capture model for self-financing a public infrastructure project. Suppose city A provides a public infrastructure, z_a, such as roads, mass transit system, fire protection, and etc. The total cost of operating a public good z_a is denoted by $C_a(z_a)$, since the cost function $C_a(z_a)$ is convex. For simplicity, in this case we assume that the residents in city A do not consume other public goods except the z_a. Itis assumed that all of dwellers have identical preferences and incomes which is denoted by a common utility function (U), and all residents pay rent for their habitations. In our study, we need to add one assumption to make our analysis more accurate: the rent of each house is equal to an economic rent which is generated by establishing a public good. Therefore, this economic rent will stand for an implicit price of a public infrastructure.

Let houses in city A are represented by i, and the vector of housing attributes are denoted by q_i. The utility function of house i is determined by U (x_i, q_i, z_a). Since, x_i stands for a numeric private good. Let y represents the common income level of city A, and P_i is the rent payment of house i, therefore the budget constrain of dweller is denoted by $y = x_i + P_i$.

The model assumes that dwellers of city A can move freely and has a fixed utility level equal to the utility level found elsewhere in the economy (Brueckner

(2001: 325). If we eliminate x_i; the private good consumption through the budget constraint, the fixed utility for residents of a city A is;

$$\overline{U} = U(y - P_i, q_i, z_a) \tag{3.15}$$

Since, the utility level is given by U. This function (3.15) defines P_i as a function of q_i, and z_a, with derivatives,

$$\frac{\partial P_i}{\partial z_a} = \frac{U_i^z}{U_i^x} \tag{3.16}$$

And,

$$\frac{\partial P_i}{\partial q_i} = \frac{U_i^q}{U_i^x} \tag{3.17}$$

Therefore, when attributes of a house or the public good levels increase, the rent for house i will increase at a rate equal to the marginal rate of substitution (MRS) between public good and x.

In addition, we need to investigate the impact of a marginal public improvement, good z_a, on the property value in city A. Let's assume that the levels of a home's attributes, q_i, for all houses in the city are held fixed as z_a increase. Because Due rental is a function of z_a, therefore P_i (z_a) is a rent level for house i if the house is located within the neighborhood A. Total rent of house in the city A, R(.), is denoted by

$$R_a(z_a) \equiv \sum_{i \in \alpha} P_i(z_a) \tag{3.18}$$

From (3.18), the derivatives of $R_a(z_a)$ is given by

$$R'_a(z_a) = \sum_{i \in \alpha} MRS_i^{z,x} \tag{3.19}$$

Since,

$$MRS_i^{z,x} = \frac{U_i^z}{U_i^x} \qquad (3.20)$$

Thus, as the level of the public good z_a increases, the total rent in city A will increase equal to the marginal benefit of the z_a. Therefore, the property value, in sense of housing rent, reflects the marginal social benefit of the specific z_a. The housing value in the city depends upon the rents they create and upon the property taxes they pay. Suppose, the city imposes a property tax at rate t. Let V_a represents the total values of house in the city, the value is defined by (3.21). Since, r is the discount rate.

$$V_a = \frac{\left[R_a - (t)V_a\right]}{r} \qquad (3.21)$$

Equation 3.21, indicates that the housing value is equal to the present discount value of the rental payment minus property tax; therefore, the V_a value after calculation is

$$V_a = \frac{R_a(z_a)}{t + r} \qquad (3.22)$$

Without loss of generality, the assumption in this case is that all of the property taxes are used to finance the construction cost of the public good z_a. Hence, the budget constraint of city A can be written as $t(V_a) = C_a(z_a)$. Using equation (3.22), the budget constraint can be rearranged as.

$$\frac{t\left[R_a(z_a)\right]}{t + r} = C_a(z_a) \qquad (3.23)$$

To identify the resulting solution, the total property tax from all property should be equal to the total public good costs. As a result, property value is equal to the rental minus tax; therefore, the total value can be denoted as $\left[R_a(z_a) - C_a(z_a) - K\right]/r$. The first-order condition for choice of z_a is shown as;

$$R_a^{/}(z_a) = C_a^{/}(z_a) \qquad (3.24)$$

Thus, the marginal change in rent from an increase in z_a should be equal to the cost of the marginal improvement of the public good. From (3.19), we can reduce (3.24) to the Samuelson optimality condition.

$$\sum_{i \in \alpha} MRS_i^{z,x} = C_a^{/}(z_a) \qquad (3.25)$$

Equation (3.25) implies that the marginal social benefit from an increase in the public good is equal to the marginal cost. Thus, property value maximization brings to an efficient preparation of public good.

3.2.2 Estimated Property Value Capture Tax

In this step, we need to compute the appropriate rate of property value capture tax, or betterment tax, for refinancing a public project based on an investment cost of the public construction. The value capture tax burden for each property owner will be calculated from the amount of the incremental value, or an implicit price of public transportation. In this case, the evaluated betterment tax is collected from an individual whose property is located within three assessment areas[3]; 1,000 meters,

[3]In Bangkok, most people prefer to use motorcycle taxi to go to a desired destination if a distance is not too long; for example 1,000 or 2,000 meters to the destination. Therefore, this study decided to choose the three distances which are 1,000 meters, 1,500 meters and 2,000 meters of sky train stations to be an assessment area because the impact of the stations might still remain on the price of condominium projects which located within 2,000 meters.

1,500 meters, and 2,000 meters from five stations[4] of the Light Green Lines Extension[5]. The extension lines were constructed from 1st September 2006 to 11th August 2011, and opened on 12th August 2011 (http://www.bts.co.th/corporate/en/01-about-history.aspx). Therefore, we need to adjust the construction cost which occurred in year 2006 to be a future value at year 2013 because construction of our samples was completed in the year 2013. The future value (FV) of initial cost in several periods is as follow:

$$FV = C_0 \times (1+r)_1 \times (1+r)_2 \times .... \times (1+r)_t \tag{3.26}$$

or,

$$FV = C_0 (1+r)^t \tag{3.27}$$

Since, FV stands for future value of an initial cost of public investment, C_0 is the initial cost of construction at time 0, r stands for the interest rate, and t is the number of periods counted from construction period.

To ensure fairness to property owners, we cannot impose the total amount of the construction cost to the owner because the beneficiaries of the public project are not only the condominium's owners. The windfall gains also belong to the other groups of real-estate holders such as lands, detach houses, commercial areas, and etc. Thus, a suitable tax burden for the condominium holders should be calculated from a portion of condominium's land area to the entire land area in each assessment zone; that is, owners whose property is located within 1,000 meter, 1,500 meter, and 2,000 meter from the stations. It implies that the portion of total betterment tax imposing is same as the portion of land use. The formula is as (3.28)

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[4] Bang Chak station, Punnawhiti station, Udom Suk station, Bang Na station, and Bearing station.

[5] The Light Green Lines Extension (On Nut to Bearing station) was invested by the Bangkok Metropolitan.

$$Tax_{portion} = \frac{L_{condominium}}{L_{total}} \tag{3.28}$$

Since, $Tax_{portion}$ stands for the portion of tax burden which the property owner should bear, $L_{condominium}$ is a total amount of condominium's land area in each target zone, and L_{total} is an entire land area in each zone. Total tax burden for condominium projects locate within the assessment area will be calculated from tax portion multiply by an initial cost of the sky train station's construction. The formula is as (3.29)

$$Tax_{burden} = C \times Tax_{portion} \tag{3.29}$$

Since, Tax_{burden} stands for the total tax burden which the property owner should bear, C is an initial cost of the public project investment. After we complete calculating the tax burden, we can bring that amount of tax to estimate the betterment tax rate for each property owner by using the formula as follow,

For a case of one-time tax,

$$\textit{Total tax burden} = \textit{tax rate} \times \textit{implicit price} \tag{3.30}$$

From equation (3.30), we can calculate a one-time tax rate which will be levied on condominium's holder because we already know the implicit price of public transportation and the tax burden. However, in cases where the property owner faces a financial constrain, they can elect specific payment options, such as a one-time payment, or an annual payment. The formula for a case of annual tax is as follow;

$$Tax_{annual} = \left(\frac{r}{1-V}\right) \times Tax_{total} \tag{3.31}$$

Since,

$$V = \left(\frac{1}{1+r}\right)^{t} \tag{3.32}$$

Therefore,

$$Tax_{annual} = \left[\frac{r}{1 - \left(\frac{1}{1+r} \right)^{t}} \right] \times Tax_{toatl} \qquad (3.33)$$

Where, Tax_{annual} stands for the annually tax burden which the property owner should bear, r is a discount rate, t is a period of time, and Tax_{total} is a total amount of betterment tax or total tax burden for the property holder.

3.3 Methodological Issue

3.3.1 Datasets and Data Sources

The data used in this analysis was collected from three sources; the first source was the Department of Land, via http://condosearch.dol.go.th/Search/; this website was used to search for the primary profile of condominium projects which are located within Pra Khanong district and Bang Na district due to their proximity to the Light Green lines Extensions (On Nut to Barring station). Our targeted properties for this study were condominiums that were completed construction in the year 2013. Our second source was condominium brokers. In order to ascertain market prices and structure characteristics of condominiums, we searched advertisement on http://www.kobkid.com/bts_condo.php, http://www.checkraka.com, and http://www.thinkofliving.com/ to determine asking price and structural characteristics. We called the broker if the advertisement lacked the specific information we needed on the condominium attributes. Our third source was the geographic information system (GIS) of Bangkok through the database of the Google Earth to measure a straight-line distance from the condominium proxy to the nearest accessibility variable; main-road, sky train station, and central business district (CBD). The total number of condominiums locate within both district was 205 condominiums including 43,609 units. We selected sample size by using Yamane (1967)'s formula as follow,

$$n = \frac{N}{1 + N(e)^2} \qquad (3.34)$$

Where, n is a sample size, N is a population size, e is an error term at the 0.05 significant level. From total population of condominiums, 43,609 units therefore the amount of sample size is 396 unit.

In this study, we chose a stratified random sampling which is a method of sampling from a population. In this stratification process, members of the population are divided into homogenous strata, including an appropriate number of participants from each stratum which correspond to the subpopulation. In order to determine the sample size in each stratum, the proportional sampling will be applied for each stratum. From the population of condominium units; 43,609 units which locate within the Pra Khanong district and the Bang Na district, the number of sample in each district includes 305 condominium units and 91 condominium units respectively. In a field survey, when we go to collect data from the Pra khanong district; we found that we can receive the 303 unit of condominium from that area due to the condominium unit that real-estate owners ready to sale in that time is only 303 units. For making our research stronger, we decide to increase the number of collected data in the Bang Na district instead. The datasets in this study include 441.00 observations; which is 303 units from the Pra Khanong district, and 138 units from the Bang Na district (Table 3.2). A collection of the data during eight month period; December 2013 to August 2014.

Table 3.2 Stratified Random Sampling

District	Number of condominium projects	Number of condominium units	Proportional sampling	Number of observation from the formula	Number of observation from the field survey
Pra Khanong district	186.00	35,578.00	0.77	305.00	303.00
Bang Na district	19.00	8,031.00	0.23	91.00	138.00
Total	**205.00**	**43,609.00**	**1.00**	**396.00**	**441.00**

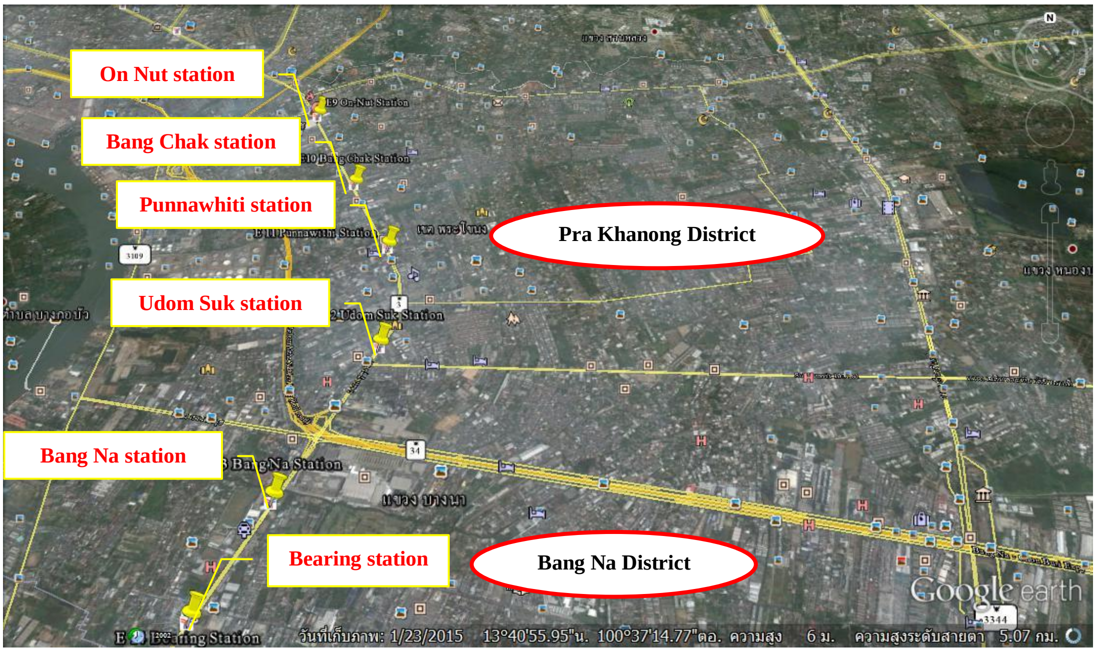

Figure 3.4 Light Green lines Extensions (On Nut to Barring station)

3.3.2 Variables and Assumption

This research will apply the concept of Hedonic Price Model (HPM) in order to estimate an implicit price of property which benefitted from the public transportation project: the Light Green Lines Extensions (On Nut to Barring Stations). In this analysis, we attempt to use the log-linear, and linear Box-Cox functional form because the various functional forms will give strong support and reliability of the estimated findings. The variables and assumptions for both functional forms can be separated in two aspects; 1) dependent variable is the asking price of condominium unit in both study districts, and 2) independent variable including several impact factors which influenced the price of our sample. The details are shown as follow,

3.3.2.1 Dependent Variable

The dependent variable is a variable which depend on an independent variable. The dependent variable is expected to alter when the independent variable is changed. In this study, the dependent variable is a market sale price (PRICE).

PRICE is a measure of market value of condominium unit in district j, in terms of baht per unit. The data is collected by asking the condominium broker or property owner about the asking price which is published in various pamphlets, brochures, and the website of condominium project in district j.

3.3.2.2 Independent Variable

The independent variable is a variable which does not depend on the other variables but the independent variable is a cause and influence to the dependent variable. The independent variables in this study include: structure variables, neighborhood variables, and accessibility variables.

1) Structure Variables

(1) AGE is a continuous variable that represents the age of the condominium building in years calculated from the date of construction completion. The assumption is: if the age of building is higher, a market sale price of room unit will decrease.

(2) HIGHT is a continuous variable represents for the number of condominium’s stories. The assumption is: the more stories contained in the condominium structure, the price increase.

(3) NOBUILD variable stands for the number of building of the condominium project. As the number of buildings in the complex increase, the selling price of condominium unit will decrease because the average cost of construction per room might be lower.

(4) UNIT variable is the number of units contained in each condominium structure. This variable might have a negative effect on the market price because more units imply a lower average construction cost.

(5) SQM_AREA variable represents the gross land area in square meters for each condominium’s project. The assumption is: if the condominium project has more land area, the selling price of each condominium unit might increase.

(6) RFLOOR variable stands for floor level. The assumption is: a room located on a higher floor might be expensive than a room located on a lower floor because the higher floor has a better view.

(7) LOTSIZE variable represents size of unit in square meter. This variable might give a positive impact to the market sale price because more gross area implies to more utility area for residents.

(8) POOL stands for swimming pools, which are offered by condominiums, indicated by dummy variables. The dummy variable is given to 1

if the project has at least one swimming pool; otherwise it is 0. The assumption is: the POOL variable might have a positive effect to the selling price.

(9) FITNEES variable is fitness room provided by condominium project is indicated by dummy variables. The value of dummy variable is equal to 1 if the condominium has at least one fitness room; otherwise it is equal to 0. The assumption is: the variable might give a positive effect to the market sale price.

(10) GREEN_ENVI variable represent a good environmental quality such park or green area is indicated by dummy variables. If the condominium includes a green area in its project, the dummy variable value is given to 1; otherwise it is 0. The assumption is: the GREEN_ENVI variable might give a positive effect to the market sale price.

(11) DUPPH variable stand for type of unit, which indicated by dummy variable. If the room is a duplex or penthouse, the value of dummy variable is given to 1; otherwise it is 0. The assumption is: the DUPPH variable might have a positive effect on the market sale price because the duplex and penthouse type should be more expensive than other type.

(12) NEWROOM variable is a dummy variable which stands for a new unit. If the unit is a new unit, the dummy variable value is equal to 1; otherwise it is equal to 0. The assumption is: if the condominium unit is new, the market sale price might be higher than a previously owned unit.

(13) BATH variable is a continuous variable, which represents the number of bathrooms in each unit. This variable might have a positive impact on the selling price of condominium because more bathrooms represent a greater cost of construction.

(14) BEDROOM variable stands for a number of bedrooms which is a continuous variable. If condominium unit has more bedrooms, the market sale price will be increase.

(15) FUR variable represents a room which is fully furnished which is a dummy variable. If the condominium unit is fully furnished, the value of the dummy variable is 1; otherwise it is 0. This variable might have a positive impact to the selling price of condominium because the cost of construction might be higher than a vacant unit.

2) Neighborhood Variable

MALL_DIST variable stands for a straight-line distance to the shopping mall, which is a continuous variable. Our study area included four malls: Lotus Supper Center, Big C Supper Store, Seacon Square, and Central Bang-Na. The assumption is: if a condominium is located adjacent to a shopping mall, the selling price of unit might be higher because residents consume less time for goods purchasing. Thus, the MALL_DIST variable should provide a negative impact to the selling price

3) Accessibility variables

(1) MAINROAD_DIST variable represents a straight-line distance, in meters, to the nearest main road; it is a continuous variable. The main road in this study includes the Sukhumvit Rd., the Srinakharin Rd., and the Bangna-Trad Rd. Due to increase accessibility, if a condominium is located in proximity to a main road, the market sale price of the unit should be higher than the same unit which is located farther away from a main road. Therefore, the variable's coefficient should have a negative sign.

(2) CBD_DIST variable stands for a straight-line distance, in meters, to the Asoka station which is chosen to be the central business district of Bangkok. The assumption is: if a condominium is located more closely to the Asoka station, the market price of a condominium unit should be more expensive. Thus, the CBD_DIST variable should provide a negative sign on the condominium's price.

(3) BTS_DIST variable stands for a straight-line distance, in meters, to the nearest five sky train stations including: Bang Chak, Punnawithi, Udom Suk, Bang Na, and Bearing. The market price of condominium unit adjacent to a sky train station should be higher due to the increased accessibility of the property. Therefore, the variable's coefficient should be negative. In this study, we chose a straight-line distance instead of a walking-distance because the longest distance from our sample to the nearest sky train station is 7,563.38 meters; therefore the straight-line distance is more appropriate and consistent in reality than using the walking-distance. Moreover, the straight-line distance has been used in several works of hedonic pricing; such as Henneberry (1998), Boarnet and Chalermpong (2001), Bae et.al (2003), McMillen and McDonald (2004), Debrezion et.al (2006), Anderson, Shyr, and Fu (2010), Wang (2010), and Cervero and Kang (2011).

CHAPTER 4

EMPIRICAL RESULTS

4.1 Research Design

This research has two important hypothetical questions which are: how much an impact of the public transportation scheme on the value of adjacent properties?, and what is an appropriated property value capture tax rate to recover the public transportation scheme? This study is divided into two steps in order to answer the two questions. The first step employs the hedonic price method (HPM) to estimate the incremental gains; or an economic rent, that occur to any property which is located along a sky train; the Light Green Lines Extensions (On Nut to Bearing station). Then, the empirical result, which is estimated from the hedonic price method, will be used to apply a concept of value capture taxation in order to refinance the Light Green lines Extensions project. Therefore, the second question will be answered in the first step.

4.2 Data and Descriptive

The datasets used in this research have been collected by two sources. Firstly, the data about market sale price and structural characteristics of condominiums were obtained from property owners and condominium brokers by interview and internet website search during the period from December 2013 to August 2014. Since, the “Light Green Lines Extensions” includes five stations from On Nut station which are: Bang Chak, Punnawithi, Udom Suk, Bang Na, and Bearing station. The distance of these five stations is 5.25 kilometers. Secondly, the data about accessibility of the proxy to the nearest BTS station, main road, and central business center (CBD) was determined by the geographic information system (GIS). In this case, I applied the GIS’s database from the Google Earth. The total amount of 441 condominium units

Figure 4.1 Condominium Projects Located Proximity to the Light Green Lines Extensions Station

4.2.1 General Characteristics of the Samples

Table 4.1 shows some general characteristics of the proxy's condominiums which are located in two districts which are Prakhanong distirct and Bang Na district and located on three locations: the Sukhumvit Rd., the Srinakharin Rd., and the Bangna-Trad Rd. Since, the majority of samples, 53 condominiums are located on the Sukhumvit Rd. while 18 samples are placed on the Srinakharin Rd. and 6 samples are located on the Bangna-Trad Rd. respectively. From the survey, we found that the highest condominium has 39 stories which is placed on Sukhumvit Rd. The sample's condominiums which are adjacent to the Bangna-Trad Rd. provide the highest average room units (4,046 units). Furthermore, the proxy's condominiums on Srinakharin Rd. provide the highest average land areas that are 16,977.28 square meters and also have the maximum land areas (59,585.56 square meters).

Table 4.1 General Characteristics of the Sample's Condominium

Location	No. of condo	No. of floors (level)			No. of room units (units)			Land area (square meters)		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Sukhumvit Rd.	53.00	12.28	5.00	39.00	323.74	56.00	1386.00	8,858.24	1,017.76	37,830.03
Srinakarin Rd.	18.00	10.67	5.00	25.00	802.06	55.00	2,190.00	16,977.28	1,471.80	59,585.56
Bangna-Trad Rd.	6.00	11.50	8.00	29.00	866.50	154.00	4,046.00	9,300.80	2,864.00	27,200

Source: From Survey

4.2.2 Descriptive Statics

The datasets used in this study provide the necessary variables for the research and stand for a random sample of the population. The descriptive statistics of the variables are shown in Table 4.2. The average market sale price of the 441 samples is 2,955,497.02 baht per unit when 10,500,000 baht per unit is the maximum market sale price, and a minimum value is 310,000.00 baht per unit. The data of samples' condominium indicates that an average age of samples was 5.311 years old; it should be noted that only condominium with construction completions dates before 2014 in this study. The maximum structure age was 22 years old, while the minimum age was 1 year old. The number of stories range from 5 floors to 39 floors. The average lot size of the proxies is 45.789 square meters while the maximum size is 150.00 square meters. This study used the distance to the nearest shopping mall to be the proxy of the neighborhood variable. An average distance from the property to the nearest mall is 1,786.87 meters and the minimum distance is 210.14 meters. The accessibility variables included 3 main variables: (1) a straight-line distance to the main road, (2) a straight-line distance to the nearest BTS station, and (3) a straight-line distance to the Asoka station (this variable stand for distance to the Central Business District (CBD). The ranking distance to the nearest BTS station of the samples is between 54.92 meters to 7,563.38 meters, since an average distance is 1,433.72 meters. The other details are in the Table 4.2

Table 4.2 Descriptive Statics

Variable	**Descriptive**	**Unit of measurement**	**mean**	**Min**	**Max**	**S.D.**	**Expected sign**
Dependent variable							
PRICE	Market sale price	Baht/unit	2,955,497.02	310,000.00	10,500,000.00	1,680,787.69	
***1. Structure variable*s**							
AGE	Age of building	Years	5.311	1.000	22.000	5.084	(-)
HEIGHT	Number of stories	Floors	12.662	5.000	39.000	7.818	(+)
NOBUILD	Number of building	Building	2.222	1.00	9.000	1.776	(+)
UNIT	Total number of units	Units	519.746	55.000	4046.000	646.040	(-)
SQM_AREA	Size of land area	Square meters	11,307.93	1,017.76	59,585.56	10,583.37	(+)
RFLOOR	Level of floor room	Level	7.580	1.000	31.000	5.556	(+)
LOTSIZE	Size of room	Square meters	45.789	20.800	150.000	19.404	(+)
BATH	Number of bathroom	Units	1.143	1.000	4.000	0.387	(+)
BEDROOM	Number of bedroom (studio = 0 unit)	Units	1.150	0.000	3.00	0.640	(+)

Table 4.2 (Continued)

Variable	Descriptive	Unit of measurement	mean	Min	Max	S.D.	Expected sign
Dummy variables							
POOL	Swimming pool	Yes=1: No = 0	0.912	0.000	1.000	0.284	(+)
FITNESS	Fitness room	Yes=1: No = 0	0.909	0.000	1.000	0.288	(+)
GREEN_ENVI	Park or green area	Yes=1: No = 0	0.771	0.000	1.000	0.421	(+)
DUPPH	Type of room	= 1 if a duplex or penthouse = 0 if otherwise	0.018	0.000	1.000	0.134	(+)
NEWROOM	New unit	Yes=1: No = 0	0.197	0.000	1.000	0.398	(+)
FUR	Fully furnished	Yes=1: No = 0	0.732	0.000	1.000	0.443	(+)
2. Neighborhood variable							
MALL_DIST	Distance to the nearest shopping mall	Meters	1,786.87	210.14	3,874.65	1,026.59	(-)
3. Accessibility variable							
MAINROAD_DIST	Distance to the nearest main road	Meters	321.223	0.005	1652.210	357.231	(-)
BTS_ DIST	Distance to the nearest BTS station	Meters	1,433.72	54.92	7,563.38	1,786.38	(-)
CBD_DIST	Distance to the Asoka station	Meters	8,119.84	3,843.48	15,159.38	2,362.87	(-)

Source: From Survey

4.3 Empirical Results

4.3.1 Diagnostic Test for Cross Sectional Analysis

The problem of multicollinearity and heteroscedasticity might lead to an inefficiency and unbiased parameter estimation on a cross sectional analysis. Therefore, before estimating the economic rent of the sky train station (the Light Green lines Extensions, On Nut to Bearing station) we need to test for both problems. This study has four equations to estimate the implicit price or economic rent of the sky train station; which include one equation from the double – log model, and three equations from the Box-Cox model. The general diagnostic tests for four hedonic pricing equations are shown as follow.

4.3.1.1 Multicollinearity Problem

In this study, we apply a variance inflation factor (VIF) to help detect multicollinearity problem. If the VIFs exceeding 10, it means that the model will face a serious multicollinearity problem. The diagnostic tests for each equation are found that every eqautions; double log equation, RHBC equation, RBC equation, and UBC equation are no multicollinearity problem because the VIFs are less than 10 for every equation (see Appendix A).

4.3.1.2 Heteroscedasticity Problem

This study uses the Breusch-Pagan test for testing the heterosceasticity problem under the hypothesis:

Ho: Constant variance

Ha: Inconstant variance

The testing results from the Appendix A show that we accept the null hypothesis of no heteroscedasticity for two equations; the RBC model and UBC model because the chi-square value are small, indicate that heteroskedasticity is probably not a problem. However, the double log model and RHBC model have a large scale of the chi-square value; therefore we failed to accept the null hypothesis. For relaxing the heteroscedasticity problem which occur in both models; double log model and RHBC model, we employed the robust standard errors (see Appendix A) to relax the problem. After using the robust standard errors, the coefficient estimation does not change but the test statistics will give a reasonably accurate p values.

4.3.2 Estimation of Implicit Price of the Sky Train Station

This section will present the results from different model specifications of the hedonic price method of the Light Green lines Extensions, On Nut to Bearing station. The models include two equations which are double – log model, and Box-Cox model. The result of each equation is reported in Table 4.3.

Table 4.3 Hedonic Price Functions for Residential Condominium Market

	Pre-specific functional form	**Box – Cox transformed functional forms**		
Variable	**Double log model Coefficient (*t-value)***	**Box-Cox model with independent variable transformations: RHBC Coefficient (*t-value)***	**Separate both-side Box-Cox model: RBC Coefficient (*t-value)***	**Basic both-side Box-Cox model: UBC Coefficient (*t-value)***
constant	13.1063***	678,218.5	35.51236***	65.27256***
	(20.94)	(0.37)	(13.40)	(4.72)
Structure variable				
AGE	-0.1369823***	-375,519.1***	-0.8219836***	-2.665493***
	(-5.28)	(-4.82)	(-6.07)	(-5.90)
HEIGHT	0.2673993***	796,914***	1.385005***	6.049077***
	(5.19)	(4.48)	(5.44)	(5.59)
NOBUILD	0.0960056**	413,282***	0.8289193***	1.97823***
	(2.23)	(2.88)	(3.16)	(2.69)
UNIT	-0.2295469***	-731,059.6***	-0.8145221***	-6.671937***
	(-6.62)	(-5.69)	(-7.34)	(-7.58)
SQM_AREA	0.0523135**	234,780.3**	0.1165501**	2.090704***
	(2.04)	(2.54)	(2.35)	(2.80)
POOL	-0.2206207***	-58,0181***	-1.676158***	-4.069158***
	(-3.89)	(-3.63)	(-4.19)	(-4.04)
FITNESS	0.4345539***	396,953.1	2.802948***	6.881229***
	(5.72)	(1.54)	(5.85)	(5.76)
GREEN_ENVI	0.1677143***	260,763.9**	1.115849***	2.889914***
	(3.70)	(1.99)	(4.01)	(4.07)

Table 4.3 (Continued)

Variable	Pre-specific functional form	Box – Cox transformed functional forms		
	Double log model Coefficient (*t-value)*	**Box-Cox model with independent variable transformations: RHBC Coefficient (*t-value)***	**Separate both-side Box-Cox model: RBC Coefficient (*t-value)***	**Basic both-side Box-Cox model: UBC Coefficient (*t-value)***
RFLOOR	0.0311061	107,009.3	0.1641884	0.6400628
	(1.46)	(1.50)	(1.22)	(1.36)
LOTSIZE	0.8210964***	2,286,862***	3.214874***	18.50248***
	(11.80)	(10.74)	(12.17)	(12.74)
DUPPH	0.1381296	1,498,594***	1.071716	3.0283*
	(1.79)	(2.71)	(1.52)	(1.71)
NEWROOM	0.0575013*	402,315.9***	0.4480564*	1.207714*
	(1.67)	(3.19)	(1.66)	(1.75)
BATH	0.0887135	953,373.1***	0.2158519	1.582299
	(1.40)	(3.05)	(0.51)	(1.38)
BEDROOM	0.0157214***	9,510.496	0.8092137***	1.748897***
	(4.16)	(1.11)	(3.56)	(3.04)
FUR	0.1052889***	31,1057.9***	0.8603181***	2.014689***
	(3.57)	(2.97)	(3.78)	(3.50)
Neighborhood variable				
MALL_DIST	-0.0554516**	7,232.646	-0.1326404**	-1.561898**
	(-2.46)	(0.10)	(-2.06)	(-2.40)
Accessibility variable				
MAINROAD_DIST	-0.0203152***	-84,290.06***	-0.1417854***	-0.4378797***
	(-3.68)	(-3.35)	(-3.93)	(-3.34)
CBD_DIST	-0.0495664	-526,358.3**	-0.1311131	-2.601837
	(-0.55)	(-2.03)	(-0.80)	(-1.09)
BTS_DIST	-0.0946134***	-215,715.4***	-0.2347787***	-2.787523***
	(-6.48)	(-4.32)	(-4.89)	(-6.96)
Transformation parameters	-	$\lambda = 0$ (p- value = 0.878)	$\lambda = \theta =$ 0.1324309 (p- value = 0.001)	$\lambda = -0.0721928$ (p-value = 0.399) $\theta = 0.1959884$ (p- value = 0.000)

Table 4.3 (Continued)

Variable	Pre-specific functional form	Box – Cox transformed functional forms		
	Double log model Coefficient (*t-value)*	**Box-Cox model with independent variable transformations: RHBC Coefficient (*t-value)***	**Separate both-side Box-Cox model: RBC Coefficient (*t-value)***	**Basic both-side Box-Cox model: UBC Coefficient (*t-value)***
R^2	0.8216	0.7650	0.8158	0.8184
Adjusted R^2	0.8136	0.7544	0.8075	0.8102
SSR	26.8463594	2.9214e+14	1,340.37283	8,563.49437
AIC	57.18242	13,295.18	1,781.745	2,599.606
BIC	138.9633	13,376.96	1,863.526	2,681.387
Number of observations	441	441	441	441

Source: Form Calculation.

Note: * Represent significant result at the one-tailed 0.001 confidence level

**Represent significant result at the one-tailed 0.05 confidence level

***Represent significant result at the one-tailed 0.01 confidence level

4.3.2.1 Double – Log Model

The result from Table 4.3 indicted that of the nineteen explanatory variables in the model, fifteen variables are significant. The double-log model implies to the elasticity of any continuous variables, which are in natural logarithms, to the market sale price of the observations. The empirical equation from double-log model is in (4.1).

$$LnPRICE = 13.1063 - 0.1369823 LnAGE + 0.2673993 LnHIGHT + 0.0960056 LnNOBUILD$$
$$- 0.2295469 LnUNIT + 0.0523135 LnSQM\_AREA - 0.2206207 POOL + 0.4345539 FITNESS$$
$$+ 0.1677143 GREEN\_ENVI + 0.8210964 LnLOTSIZE + 0.0575013 NEWROOM$$
$$+ 0.0157214 LnBEDROOM + 0.1052889 FUR - 0.0554516 LnMALL\_DIST$$
$$- 0.0203152 LnMAINROAD\_DIST - 0.0946134 LnBTS\_DIST \quad (4.1)$$

The coefficient of any independent variables can be explained as follow,

Constant term, C, is equal to 13.1063 implies that if all other things remaining equal, the cost of construction of each unit of room is 492,032.48 baht.

The LnAGE variable stands for building age in years in natural logarithms. The number, -0.1369823, reflects to the elasticity of the age of condominium to its market price. It implies that if the age of condominium increases by 1%, the market price of sample will decrease by 0.1369823%.

The LnHIGHT variable stands for the number of condominium stories in natural logarithms. The coefficient is + 0.2673993 which reflects as the number of stories increase by 1%, the market price will increase by 0.2673993%.

The LnNOBUILD variable stands for the number of condominium building projects and is in a natural logarithm. The number, + 0.0960056, implies to the elasticity of number of building. If number of building increase by 1%, the market sale price of the sample will increase 0.0960056%.

The LnUNIT variable is the number of unit of each condominium in natural logarithms. The number - 0.2295469 implies that the number of unit will give negative effect to the market sale price. If the condominium increases its unit by 1%, the market price will decrease by 0.2295469% due to an average cost of construction per unit of room will decrease.

The LnSQM_AREA variable represents the parcel size in square meters for each condominium's project in natural logarithms. The number of coefficient which is received from the equation is +0.0523135; indicating that if the size of land increases by 1%, the market price of samples will be increases increased by 0.0523135%

The POOL stands for swimming pools, which are offered by condominiums, indicated by dummy variables. The coefficient -0.2206207 means that if condominium project offer at least one swimming pool, the market sale price will decrease by 22.06207%.

The FITNESS variable is fitness room provided by condominium project which indicated by dummy variables. The number + 0.4345539 implies that if condominium offers at least one fitness room, the market sale price will increase by 43. 45539%.

The GREEN_ENVI variable is green environmental park or green area around the dwelling project which indicated by dummy variables. The coefficient + 0.1677143 means that if condominium offers the green area in the project, the market sale price will increase by 16.77143%

The LnLOTSIZE variable represents size of condominium unit. The number of + 0.8210964 implies that if size of the lot is increase by 1%, the market price will increase by 0.8210964%

The NEWROOM variable is a dummy variable which stands for a new unit. The coefficient + 0.0575013 means that if the lot is a new unit the sale price will increase by 5.75013%

The LnBEDROOM is number of bedroom which is a continuous variable. The number of + 0.0157214 implies that if number of bedroom increase by 1% the market sale price per room will increase by 0.0157214%

The FUR variable represents a unit which is fully furnished, the dummy variable. The coefficient + 0.1052889 means that if the unit is fully furnished, the market price will increase by 10.52889%

The LnMALL_DIST variable stands for distance to the shopping mall, which is a continuous variable. The number of -0.0554516 means that if the sample is located farther away from a shopping mall by 1% the market price of condominium will decrease by 0.0554516 %

The LnMAINROAD_DIST variable represents distance to the nearest main road is indicated by continuous variable. The number of -0.0203152 implies that if condominium located farther away from the main street by 1%, the price of condominium will decrease 0.0203152% that is provided a negative effect to the market price .

The LnBTS_DIST variable stands for distance to the nearest sky train station in term of meters. The coefficient -0.0946134 means that if condominium is located farther away from the sky train station by 1%, the market sale price will decrease by 0.0946134%. The result indicated that the distance to the nearest station provides the negative effect as expected. It should be noted that; the result is roughly -0.09 which is similar to the result of Saksith Chalermpong (2007).

4.3.2.2 Box – Cox Model

Three different forms of the Box-Cox transformation are shown on the Table 4.3: a transformation only on independent variable (RHBC); a transformation on the both sides of the equation with the same parameter (RBC); and transformation using the different values on both side of the equation (UBC). A test of Box – Cox functional forms for the best fit transformation is considered by values of the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). As shown on Table 4.3; the RBC model has the lowest AIC and BIC values, which recommend that it is the best transformation. The details of each transformation will be shown as follows;

1) RHBC Model

The Box-Cox parameter from Table 4.3 for the RHBC model, λ, is equal to 0 which indicated that the model is a semi – log model. The result form Table 4.3 indicted that of the nineteen explanatory variables in the RHBC model, fifteen variables are significant. The empirical equation from RHBC model is in (4.2).

PRICE = – 375,519.1LnAGE + 796,914LnHIGHT + 413,282LnNOBUILD – 731,059.6LnUNIT + 234,780.3LnSQM_AREA – 580,181POOL + 260,763.9GREEN_ENVI + 2,286,862LnLOTSIZE + 1,498,594DUPPH + 402,315.9NEWROOM + 953,373.1LnBATH + 311,057.9FUR – 84,290.06LnMAINROAD_DIST – 526,358.3LnCBD_DIST – 215,715.4LnBTS_DIST (4.2)

The coefficient of any independent variables can be explained as follow,

The LnAGE variable stands for building age in years in natural logarithms. The number, -375,519.1, implies that if the age of condominium increases by 1%, the market price of sample will decrease by 375,519.1 baht.

The LnHIGHT variable stands for the number of condominium's stories in natural logarithms. A coefficient is + 796,914 which reflects that if the condominium's story increases by 1%, the market price will increase by 796,914 baht.

The LnNOBUILD variable stands for the number of building of the condominium project is in natural logarithms. The number, + 413,282, implies that if number of building increase by 1%, the market sale price of the sample will increase 413,282 baht.

The LnUNIT variable is the number of unit of each condominium in natural logarithms. The number – 731,059.6 implies that the number of unit will give negative effect to the market sale price. If condominium increases its room unit 1%, the market price will decrease by 731,059.6 baht due to an average cost of construction per unit of room will decrease.

The LnSQM_AREA variable represents the parcel size in square meters for each condominium project in natural logarithms. The number of coefficient which is received from the equation is 234,780.30, which means that as the size of land increases by 1%, the market price of samples will be increases by 234,780.30 baht.

The POOL stands for swimming pools, which are offered by condominium project, indicated by dummy variables. The coefficient -580,181 means that if the condominium project offers at least one swimming pool, the market sale price will decrease by 580,181 baht.

The GREEN_ENVI variable is green environmental such park or green area provided by observation project which indicated by dummy variables. The coefficient + 260,763.90 means that if the project offers the green area in the project, the market sale price will increase by 260,763.90 baht.

The LnLOTSIZE variable represents size of unit. The number of + 2,286,862.00 implies that if size of the unit is increase by 1%, the market price will increase by 2,286,862.00 baht.

The DUPPH variable stand for type of unit, which is indicated by a dummy variable. The coefficient +1,498,594.00 means that if the type of unit is duplex or penthouse, the market sale price will increase by 1,498,594.00 baht.

The NEWROOM is a dummy variable which stands for a new unit. The coefficient + 402,315.90 mean that if the lot is a new unit the sale price will increase by 402,315.90 baht.

The LnBATH is number of bathroom which is a continuous variable. The number of + 953,373.10 implies that if number of bathroom increase by 1% the market sale price per room will increase by 953,373.10 baht.

The FUR variable represents a unit which include fully furnished, the dummy variable. The coefficient + 311,057.90 means that if the unit is fully furnished type, the market price will increase by 311,057.90 baht.

The LnMAINROAD_DIST variable represents distance to the nearest main road is indicated by continuous variable. The number of -84,290.06 implies that if condominium is located father away from the main street by 1%, the price of condominium unit will decrease by 84,290.06 baht that is provided a negative effect to the market price.

The LnCBD_DIST variable stands for distance to the Asoka station which represents the central business district of Bangkok, which is a continuous variable. The number of -526,358.30 means that if the sample locates father away from the shopping mall by 1% the market price of condominium will decrease by 526,358.30 baht.

The LnBTS_DIST variable stands for distance to the nearest sky train station in term of meters. The coefficient -215,715.40 means that if condominium located father away from the sky train station by 1% the market sale price will decrease by 215,715.40 baht. The result indicated that the distance to the nearest station provides the negative effect as expected.

2) RBC Model

The Box-Cox parameter from Table 4.3 for the RBC model, λ, is equal to 0.1324309. The result form Table 4.3 indicted that of the nineteen explanatory variables in the RBC model, sixteen variables are significant. The empirical equation from RBC model is in (4.3).

$$\frac{P^{0.1324309}-1}{0.1324309}=35.51236-1.676158POOL+2.802948FITNESS+1.115849GREEN\_ENVI$$
$$+0.4480564NEWROOM+0.860318FUR-\frac{0.82198AGE^{0.1324309}-1}{0.1324309}-\frac{0.14179MAINROAD\_DIST^{0.1324309}-1}{0.1324309}$$
$$+\frac{1.385005HIGHT^{0.1324309}-1}{0.1324309}+\frac{0.828919NOBUILD^{0.1324309}-1}{0.1324309}-\frac{0.81452UNIT^{0.1324309}-1}{0.1324309}$$
$$-\frac{0.234779BTS\_DIST^{0.1324309}-1}{0.1324309}-\frac{0.13264MALL\_DIST^{0.1324309}-1}{0.1324309}+\frac{0.1165501SQM\_AREA^{0.1324309}-1}{0.1324309}$$
$$+\frac{3.214874LOTSIZE^{0.1324309}-1}{0.1324309}+\frac{0.809214BEDROOM^{0.1324309}-1}{0.1324309}$$

(4.3)

The coefficient of any independent variables can be explained as follow,

Constant term, C, is equal to 35.51236 implies that if all other things remain equal, the cost of construction of each unit of room is 512,129.73 bath.

The POOL stands for swimming pools, which are offered by condominium project, indicated by dummy variables. The coefficient -1.676158 means that if condominium project offer at least one swimming pool, the market sale price will decrease by 688,706.03 baht.

The FITNESS variable is fitness room provided by condominium project which indicated by dummy variables. The number + 2.802948 implies that if the project offers at least one fitness room, the market sale price will increase by 1,151,686.15 baht.

The GREEN_ENVI variable is green environmental such park or green area provided by observation project which indicated by dummy variables. The coefficient + 1.115849 means that if the condominium project offers a green area in the project, the market sale price will increase by 458,484.37 baht.

The NEWROOM variable is a dummy variable which stands for a new unit. The coefficient + 0.4480564 means that if the unit is a new room the sale price will increase by 184,099.15 baht.

The FUR variable represents a unit which include fully furnished, the dummy variable. The coefficient + 0.860318 means that if the unit is a fully furnished type, the market price will increase by 353,490.84 baht.

The AGE variable stands for building age in years. The number, -0.860318, implies that if the age of condominium project increases by 1 year, the market price of sample will decrease by 79,330.43 baht

The MAINROAD_DIST variable represents distance to the nearest main road is indicated by continuous variable. The number of -0.14179 implies that if condominium project located father away from the main street by 1 meter, the price of the condominium will decrease by 389.53 baht, that is provided a negative effect to the market price.

The HIGHT variable stands for the number of condominium's stories. The coefficient is + 1.385005 which reflects that as the number of condominium stories increase by 1 floor, the market price of unit will increase by 62,903.31 baht.

The NOBUILD variable stands for the number of buildings in the condominium project. The number, +0.828919, implies that if number of building increase by 1 building, the market sale price of the sample will increase 170,375.35 baht.

The UNIT variable is the number of unit of each condominium. The number – 0.81452 implies that the number of unit will have a negative effect to the market sale price. If condominium project increases its unit by 1 unit, the market price will decrease by 1,473.96 baht due to an average cost of construction per unit will decrease.

The BTS_DIST variable stands for distance to the nearest sky train station in term of meters. The coefficient -0.234779 means that if condominium project located father away from the sky train station by 1 meter the market sale price will decrease by 176.17 baht. The result indicated that the distance to the nearest station provides the negative effect as expected.

The MALL_DIST variable stands for distance to a shopping mall, which is a continuous variable. The number of -0.13264 means that if the sample located father away from a shopping mall by 1 meter, the market price of condominium unit will decrease by 82.22 baht.

The SQM_AREA variable represents the parcel size in square meters for each condominium project. The number of coefficient which is received from the equation is 0.1165501, which means if the size of land increases by 1 square meter, the market price of samples will be increases by 14.58 baht.

The LOTSIZE variable represents size of unit. The number of + 3.214874 implies that if size of the unit is increased by 1 square meter, the market price will increase by 47,869.40 bath.

The BEDROOM is number of bedroom which is a continuous variable. The number of + 0.809214 implies that if the number of bedrooms is increased by 1 bedroom, the market sale price per room will increase by 294,525.51 baht.

3) UBC Model

The Box-Cox parameter from Table 4.3 for the UBC model, θ, the parameter for dependent variable is equal to 0.1959884 while λ is equal to 0.1324309. The result form Table 4.3 indicted that of the nineteen explanatory variables in the UBC model, fifteen variables are significant. The empirical equation from UBC model is in (4.4).

$$
\begin{aligned}
\frac{P^{0.1959884}-1}{0.1959884} &= 65.27256 - 4.069158POOL + 6.881229FITNESS + 2.889914GREEN\_ENVI \\
&+ 2.014689FUR - \frac{2.66549AGE^{-0.0721928}-1}{-0.0721928} - \frac{0.43788MAINROAD\_DIST^{-0.0721928}-1}{-0.0721928} \\
&+ \frac{6.049077HIGHT^{-0.0721928}-1}{-0.0721928} + \frac{1.97823NOBUILD^{-0.0721928}-1}{-0.0721928} - \frac{6.67194UNIT^{-0.0721928}-1}{-0.0721928} \\
&- \frac{2.78752BTS\_DIST^{-0.0721928}-1}{-0.0721928} - \frac{1.56189MALL\_DIST^{-0.0721928}-1}{-0.0721928} + \frac{2.090704SQM\_AREA^{-0.0721928}-1}{-0.0721928} \\
&+ \frac{18.50248LOTSIZE^{-0.0721928}-1}{-0.0721928} + \frac{1.74889BEDROOM^{-0.0721928}-1}{0.0721928}
\end{aligned}
\tag{4.4}
$$

The coefficient of any independent variables can be explained as follow,

Constant term, C, is equal to 65.27256 and implies that if all other things remaining equal, the cost of construction of each condominium unit is 652,943.58 bath.

The POOL stands for swimming pools, which are offered by condominium project, indicated by dummy variables. The coefficient -4.069158 means that if condominium project offer at least one swimming pool, the market sale price will decrease by 648,584.48 baht.

The FITNESS variable is fitness room provided by condominium project which is indicated by dummy variables. The number + 6.881229 implies that if condominium offers at least one fitness room, the market sale price will increase by 1,096,801.44 baht.

The GREEN_ENVI variable is green environmental park or green area provided by condominium project which is indicated by dummy variables. The coefficient + 2.889914 means that if the project offers a green area in the project, the market sale price will increase by 460,624.38 baht.

The FUR variable represents a unit which is fully furnished, the dummy variable. The coefficient + 2.014689 means that if the unit is a fully furnished type, the market price will increase by 321,121.97 baht.

The AGE variable stands for building age in years. The number, -2.66549, implies that if the age of condominium project increases by 1 year, the market price of sample will decrease by 70,910.53 baht.

The MAINROAD_DIST variable represents distance to the nearest main road is indicated by continuous variable. The number of -0.43788 implies that if condominium project located father away from the main street by 1 meter, the price of condominium unit will decrease by 143.23 baht that is provided a negative effect to the market price.

The HIGHT variable stands for the number of condominium's stories. A coefficient is + 6.049077 which reflects that if the condominium's story increases by 1 floor, the market price of unit will increase by 63,395.16 baht.

The NOBUILD variable stands for the number of buildings in the condominium project. The number, +1.97823, implies that if number of building increase by 1 building, the market sale price of the sample will increase 133,956.04 baht.

The UNIT variable is the number of unit of each condominium project. The number – 6.67194 implies that the number of unit will generate a negative effect to the market sale price. If the condominium project increases the number of unit by 1 unit, the market price will decrease by 1,302.75 baht due to an average cost of construction per unit will decrease.

The BTS_DIST variable stands for distance to the nearest sky train station in term of meters. The coefficient -2.78752 means that if condominium project located father away from the sky train station by 1 meter the market sale price will decrease by 183.38 baht. The result indicated that the distance to the nearest station provides the negative effect as expected.

The MALL_DIST variable stands for distance to the shopping mall, which is a continuous variable. The number of -1.56189 means that if the sample located father away from the shopping mall by 1 meter, the market price of condominium unit will decrease by 81.14 baht.

The SQM_AREA variable represents the parcel size in square meters for each condominium project. The number of coefficient which is received from the equation is +2.090704, and means that if the size of land increases by 1 square meter, the market price of samples will be increases by 15.02 baht.

The LOTSIZE variable represents size of unit. The number of + 18.50248 implies that if size of the unit is increase by 1 square meter, the market price will increase by 48,869.26 bath.

The BEDROOM is number of bedroom which is a continuous variable. The number of + 1.74889 implies that if number of bedrooms increase by 1 bedroom, the market sale price per unit will increase by 239,964.20 baht.

4.3.2.3 Economic Rent of the Sky Train Station

When we consider only an effect of the sky train station (the Light Green lines Extensions, On Nut to Bearing station) in four eqautions, the results from every equation indicates that the impact of the station are all negative and implies that if the condominium is located closely to the sky train station, the price of condominium unit will be higher, if other things remain equal. Table 4.4 illustrates the average implicit price; or economic rent, of the sky train station in each models are not much different, the estimated economic rent of four equations are between 150.46 to 195.04 Baht per condominium’s room for every meter closer to the sky train station. Therefore, if a condominium is located adjacent to the sky train station, the price of the room is roughly 150,460 to 195,040 Baht more than an identical condominium located 1,000 meter away when consider in average value.

Table 4.4 Average Economic Rent of the Sky Train Station in Each Equation

	Double log Form	Box-Cox Transformed Functional Forms		
		RHBC	RBC	UBC
Economic rent at average price per unit of room (Baht/meter)	-195.04	-150.46	-176.17	-183.38

Source: Form Calculation.

4.3.2 Estimation of Property Value Capture Taxation

The results from the last topic have told us about the value of an implicit price, or economic rents that are received by the property owners who dwell adjacent to the public infrastructure. Basically we know that it is unfair for the total population to pay the entire cost of a public infrastructure project that benefits only a small segment of the total population. In order to restore equity to infrastructure projects, policymakers should adopt and implement a new financial mechanism to finance new project or refinance existing projects by using the concept of benefit pay principle.

In this topic we will apply the principle of value capture taxation via a "betterment tax" to capture a portion of the windfall gains from property owners who live along the sky train station in order to reimburse the public for construction cost on public infrastructure projects, the sky train (the Light Green lines Extensions, On Nut to Barring station) by using the total value of the economic rent or implicit price of each condominium's unit as calculated from the double log equation (4.1) to estimate the amount of property value capture tax which will collect from the property owner. We have divided the tax mapping for betterment tax collecting in three assessment areas; (a) condominiums which are located within 1,000 meters from the sky train station, (b) condominiums which are located within 1,500 meters from the sky train station, (c) condominiums which are located within 2,000 meters from the sky train station. However, before go to set the tax mapping we must accurately determine the "economic rent", or the impact of the sky train station to the price of a property in each area. The details about the implicit price of the sky train to the price of condominiums in three target areas are shown as follow.

4.3.2.1 Total Economic Rent of Each Condominium

To determine the implicit price, or the economic rent of the properties which are located within the stated distances of 1,000 meters, 1,500 meters and 2,000 meters respectively to the sky train station (the Light Green lines Extensions, On Nut to Barring station), we use the double log model (4.1). The coefficient of independent variables in the equation (4.1) represents the elasticity of each independent variable to the price of condominium. For example, the coefficient of BTS_DIST is - 0.0946134 and implies that condominiums located adjacent to the sky train station by 1 percent, the price of a sample will be increase by 0.0946134 percent, ceteris paribus. Therefore, from the definition of double log equation, we can estimate a change of price of each property at each distance by setting a boundary area and estimate a sample price at the boundary distance by using the equation (4.5). For instance, if a setting distance boundary is 1,000 meter away from the sky train station; the first step is to calculate the price of a room unit of condominiums which are located 1,000 meters away from the station by using the equation (4.5) which is transformed by the equation (4.1). The second step is to estimate how the change of distance impacts the price of a room unit by assuming that if the condominium is located in proximity to the sky train station from the boundary area, 1,000 meter, by 10 percent so we will get the price change. The change of condominium unit price will be used for an "economic rent" or implicit price of every condominium in the boundary area in each distance change.

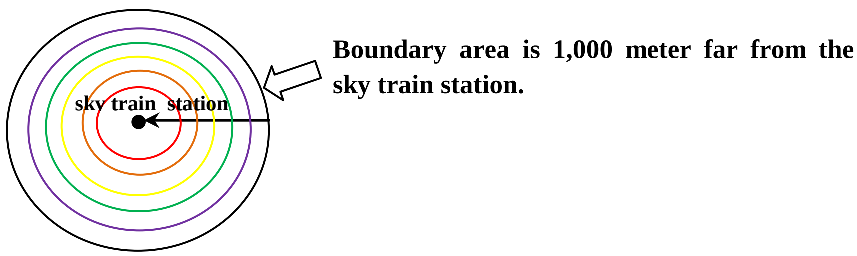

Figure 4.2 An Example of Estimating an Economic Rent of Condominium Locates within the Boundary Area

From the double log equation (4.1), we can convert it to equation (4.5) for applying to estimate the price of condominium unit in each distance by setting other variables to be constant. The equation (4.5) is shown bellow;

$$PRICE = e^{\left(\begin{array}{l} 13.1063 - 0.1369823 LnAGE + 0.2673993 LnHIGHT + 0.0960056 LnNOBUILD - 0.2295469 LnUNIT \\ + 0.0523135 LnSQM\_AREA - 0.2206207 POOL + 0.4345539 FITNESS + 0.1677143 GREEN\_ENVI \\ + 0.8210964 LnLOTSIZE + 0.0575013 NEWROOM + 0.0157214 LnBEDROOM + 0.1052889 FUR \\ - 0.0554516 LnMALL\_DIST - 0.0203152 LnMAINROAD\_DIST - 0.0946134 LnBTS\_DIST \end{array}\right)} \quad (4.5)$$

By estimating (4.5), the room unit of condominium's price which is located at 1,000 meters from the sky train station is 3,409,545.68 baht; now, we can calculate the implicit price of every room unit located within the assessment area by using the concept of "elasticity" of any change in distance to a change in price. The estimated "economic rent" of the sky train station at each distance is calculated from the "difference value" between condominium unit's price at boundary area and the estimated price at each distance. The details of the economic rent of condominiums in each assessment zone are shown as follows.

1) A change in the economic rent of condominium unit at each distance change when compare with the boundary area (1,000 meter from the sky train station).

By calculating a condominium unit price using equation (4.5), an estimated price for a condominium unit located at the 1,000 meter boundary area can be calculated at 3,409,545.68 baht per unit. From the equation (4.1) the elasticity of the distance from any condominium project to the nearest sky train station is -0.0946134, which imply that if condominium project located adjacent to the sky train station by 1 percent, the price of a room unit in that condominium project will be increase by 0.0946134 percent, ceteris paribus. Therefore, the estimated "economic rent" of the sky train station at each distance is calculated from the "difference value" between condominium unit's price at boundary area and the estimated price at each distance. For example, the condominium project number 1 (Table 4.5), which located 326.75 meter from the nearest sky train station, has -0.67 percent in "different distance" when compare with the boundary area (1,000 meter of the sky train station). Therefore, the market price of the property will be higher than the identical property which located at 1,000 meter boundary area by 0.06370 percent or 217,183.53 Baht per room unit. The different value between the price of condominium unit at assessment area and the estimated price of any condominium in each distance is implied to an “economic rent” or a “windfall gain” that belong to the condominium owners.

The number of condominium projects within the 1,000 meter boundary area, with construction completion dates in the year 2013, is forty-nine projects. These 49 projects contain a total of 13,443.00 units. The total implicit price of these projects is calculated at 2,359,072,495.61, or rounded to 2,359 million baht. This represents a significant windfall gain for these property owners; a windfall gain received without any investment required on their part. The detail for the 49 condominium projects are shown in Table 4.5.

Table 4.5 Economic Rents of Condominium Projects Located within 1,000 meter of the Sky Train Station (the Light Green Lines Extensions, On Nut to Bearing Station)

No.	Number of Units	Distance to sky train station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 1,000 m (Baht)	Price changed (economic rent) per unit (Baht)	Economic rent of each project (Baht)
1	79	326.75	-0.67	-0.0946134	0.06370	3,409,545.68	217,183.53	17,157,499.22
2	45	750.64	-0.25	-0.0946134	0.02359	3,409,545.68	80,439.59	3,619,781.70
3	96	969.19	-0.03	-0.0946134	0.00292	3,409,545.68	9,939.55	954,196.93
4	66	929.45	-0.07	-0.0946134	0.00668	3,409,545.68	22,760.15	1,502,169.62
5	79	54.92	-0.95	-0.0946134	0.08942	3,409,545.68	304,873.68	24,085,020.79
6	105	558.88	-0.44	-0.0946134	0.04174	3,409,545.68	142,299.75	14,941,473.93
7	143	316.67	-0.68	-0.0946134	0.06465	3,409,545.68	220,435.47	31,522,272.36
8	350	895.15	- 0.10	-0.0946134	0.00992	3,409,545.68	33,822.57	11,837,899.12
9	127	888.54	- 0.11	-0.0946134	0.01055	3,409,545.68	35,954.66	4,566,241.99
10	368	762.90	-0.24	-0.0946134	0.02243	3,409,545.68	76,485.91	28,146,813.98
11	77	504.35	- 0.50	-0.0946134	0.04690	3,409,545.68	159,891.22	12,311,624.06
12	154	576.65	-0.42	-0.0946134	0.04005	3,409,545.68	136,567.20	21,031,348.03
13	199	530.82	-0.47	-0.0946134	0.04439	3,409,545.68	151,353.46	30,119,338.52
14	198	530.05	- 0.47	-0.0946134	0.04446	3,409,545.68	151,599.23	30,016,648.33
15	879	467.12	- 0.53	-0.0946134	0.05042	3,409,545.68	171,900.69	151,100,706.09
16	171	796.78	- 0.20	-0.0946134	0.01923	3,409,545.68	65,557.91	11,210,402.40
17	210	467.12	-0.53	-0.0946134	0.05042	3,409,545.68	171,900.69	36,099,144.80

Table 4.5 (Continued)

No.	Number of Units	Distance to sky train station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 1,000 m (Baht)	Price changed (economic rent) per unit (Baht)	Economic rent of each project (Baht)
18	164	472.69	- 0.53	-0.0946134	0.04989	3,409,545.68	170,105.63	27,897,322.65
19	487	161.05	-0.84	-0.0946134	0.07938	3,409,545.68	270,634.37	131,798,937.98
20	122	469.19	-0.53	-0.0946134	0.05022	3,409,545.68	171,233.11	20,890,439.44
21	129	451.20	-0.55	-0.0946134	0.05192	3,409,545.68	177,037.76	22,837,870.95
22	56	271.29	- 0.73	-0.0946134	0.06895	3,409,545.68	235,073.90	13,164,138.49
23	77	530.18	-0.47	-0.0946134	0.04445	3,409,545.68	151,559.56	11,670,086.20
24	63	530.18	-0.47	-0.0946134	0.04445	3,409,545.68	151,559.56	9,548,252.34
25	1,172	159.55	-0.84	-0.0946134	0.07952	3,409,545.68	271,120.46	317,753,177.96
26	332	467.12	- 0.53	-0.0946134	0.05042	3,409,545.68	171,900.69	57,071,028.92
27	218	343.52	- 0.66	-0.0946134	0.06211	3,409,545.68	211,774.06	46,166,745.62
28	262	73.45	- 0.93	-0.0946134	0.08766	3,409,545.68	298,893.05	78,309,978.85
29	192	300.16	- 0.70	-0.0946134	0.06621	3,409,545.68	225,761.52	43,346,212.68
30	149	358.34	-0.64	-0.0946134	0.06071	3,409,545.68	206,993.27	30,841,997.87
31	234	403.94	-0.60	-0.0946134	0.05640	3,409,545.68	192,281.41	44,993,849.49
32	376	177.52	- 0.82	-0.0946134	0.07782	3,409,545.68	265,323.26	99,761,547.17
33	583	180.28	-0.82	-0.0946134	0.07756	3,409,545.68	264,431.75	154,163,711.10
34	226	719.13	- 0.28	-0.0946134	0.02657	3,409,545.68	90,606.21	20,477,002.37
35	226	789.25	- 0.21	-0.0946134	0.01994	3,409,545.68	67,985.71	15,364,770.32
36	226	746.71	- 0.25	-0.0946134	0.02396	3,409,545.68	81,708.42	18,466,102.57
37	349	686.32	-0.31	-0.0946134	0.02968	3,409,545.68	101,188.25	35,314,698.98
38	423	153.71	-0.85	-0.0946134	0.08007	3,409,545.68	273,003.90	115,480,648.09
39	413	383.63	- 0.62	-0.0946134	0.05832	3,409,545.68	198,833.06	82,118,055.67
40	779	833.00	- 0.17	-0.0946134	0.01580	3,409,545.68	53,872.31	41,966,533.01
41	146	223.00	- 0.78	-0.0946134	0.07351	3,409,545.68	250,651.43	36,595,108.40
42	810	692.30	-0.31	-0.0946134	0.02911	3,409,545.68	99,260.55	80,401,042.24
43	218	223.00	- 0.78	-0.0946134	0.07351	3,409,545.68	250,651.43	54,642,011.18
44	940	250.84	-0.75	-0.0946134	0.07088	3,409,545.68	241,670.56	227,170,324.28
45	460	805.85	- 0.19	-0.0946134	0.01837	3,409,545.68	62,630.72	28,810,131.34
46	79	266.17	-0.73	-0.0946134	0.06943	3,409,545.68	236,725.27	18,701,296.55
47	56	306.03	- 0.69	-0.0946134	0.06566	3,409,545.68	223,866.26	12,536,510.43

Table 4.5 (Continued)

No.	Number of Units	Distance to sky train station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 1,000 m (Baht)	Price changed (economic rent) per unit (Baht)	Economic rent of each project (Baht)
48	56	271.29	-0.73	-0.0946134	0.06895	3,409,545.68	235,073.90	13,164,138.49
49	74	270.00	-0.73	-0.0946134	0.06907	3,409,545.68	235,489.76	17,426,242.10
				Total Value				***2,359,072,495.61***

Source: Form Calculation.

Table 4.6 illustrates and summarizes of an estimated implicit price from the condominium projects which are located within 1,000 meter from the sky train station. An average implicit price per unit of room is 169,221.76 baht since a minimum value is 9,939.55 baht and maximum implicit price of condominium unit is 304,873.68 baht respectively. However, a total value of economic rent of the sky train station in term of condominium projects which are located within a 1,000 meter from the station are 2,359,072,495.61 baht, a minimum value per condominium project is 954,196.93 baht since the maximum value per condominium project is 317,753.177.96 baht and an average implicit price value of each condominium is 48,144,336.65 baht. A minimum distance to the station is 54.92 meter while a maximum distance is 969.19 meter and an average distance to the sky train station is 475.43 meter. The total number units of projects which are located within a 1,000 meter from the sky train station are 13,443.00 units, an average unit for each condominium project is 274.35 units since a maximum unit is 1,172.00 units and a minimum unit is 45.00 units. The average size of land of each condominium project which is located within 1,000 meter of the sky train station is 8,618.32 square meter while the minimum size is 401.80 square meter and the maximum is 37,830.03 square meter.

Table 4.6 Summary of an Estimated Economic Rents of Condominium Projects Located within 1,000 meter of the Sky Train Station

	Economic rent per unit (Baht)	Economic rent per condominium project (Baht)	Distance to sky train station (m)	Units	Land (sqm.)
minimum	9,939.55	954,196.93	54.92	45.00	401.80
maximum	304,873.68	317,753,177.96	969.19	1,172.00	37,830.03
average	169,221.76	48,144,336.65	475.43	274.35	8,618.32
Total value	-	2,359,072,495.61	-	13,443.00	422,297.52

Source: Form Calculation.

2) A change in the economic rent of condominium unit at each distance changes when compare with the boundary area (1,500 meter from the sky train station).

By calculating the room unit's price via the equation (4.5), an estimated price of a condominium unit which is located at boundary area, 1,500 meters, is 2,930,628.55 baht per unit. The number of condominium projects located within the 1,500 meter boundary area, with construction completion dates in the year 2013, is 59 projects which include the total amount of condominium unit is 14,624.00 units. The total economic rent of the condominiums projects are 2,988,644,281.37 baht, or roughly 2,989 million baht. The total value implies the unearned gain which property owner who resides within 1,500 of the sky train station can receive from the public infrastructure project. The details are shown on the Table 4.7.

Table 4.7 Economic Rents of Condominium Projects Located within 1,500 meter of the Sky Train Station (The Light Green Lines Extensions, On Nut to Bearing Station)

No.	Number of Units	Distance to BTS station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 1,500 m	Price changed (economic rent) per unit	Economic rent of each project (Baht)
1	79	326.75	-0.78	-0.0946134	0.07400	3,281,224.32	242,822.35	19,182,965.80
2	45	750.64	- 0.50	-0.0946134	0.04727	3,281,224.32	155,090.71	6,979,082.10
3	250	1,290.47	-0.14	-0.0946134	0.01322	3,281,224.32	43,365.94	10,841,485.93
4	96	969.19	- 0.35	-0.0946134	0.03348	3,281,224.32	109,859.57	10,546,519.14
5	72	1,133.25	-0.24	-0.0946134	0.02313	3,281,224.32	75,905.17	5,465,172.58
6	66	929.45	-0.38	-0.0946134	0.03599	3,281,224.32	118,084.96	7,793,607.41
7	90	1,365.17	-0.09	-0.0946134	0.00850	3,281,224.32	27,905.70	2,511,513.02
8	79	54.92	-0.96	-0.0946134	0.09115	3,281,224.32	299,082.25	23,627,497.78
9	105	558.88	-0.63	-0.0946134	0.05936	3,281,224.32	194,778.71	20,451,764.54
10	143	316.67	-0.79	-0.0946134	0.07464	3,281,224.32	244,908.72	35,021,946.47
11	350	895.15	-0.40	-0.0946134	0.03815	3,281,224.32	125,182.35	43,813,821.32
12	127	888.54	-0.41	-0.0946134	0.03857	3,281,224.32	126,550.25	16,071,881.25
13	368	762.90	-0.49	-0.0946134	0.04649	3,281,224.32	152,554.12	56,139,917.34
14	77	504.35	-0.66	-0.0946134	0.06280	3,281,224.32	206,064.98	15,867,003.13
15	135	1,077.67	-0.28	-0.0946134	0.02664	3,281,224.32	87,408.60	11,800,160.92
16	161	1,072.11	-0.29	-0.0946134	0.02699	3,281,224.32	88,558.81	14,257,967.66
17	154	576.65	-0.62	-0.0946134	0.05824	3,281,224.32	191,100.84	29,429,529.16
18	199	530.82	-0.65	-0.0946134	0.06113	3,281,224.32	200,587.35	39,916,883.10
19	198	530.05	-0.65	-0.0946134	0.06118	3,281,224.32	200,745.04	39,747,516.94
20	879	467.12	-0.69	-0.0946134	0.06515	3,281,224.32	213,769.96	187,903,797.32
21	30	1,479.36	-0.01	-0.0946134	0.00130	3,281,224.32	4,271.00	128,129.97
22	171	796.78	-0.47	-0.0946134	0.04436	3,281,224.32	145,542.98	24,887,849.72
23	210	467.12	-0.69	-0.0946134	0.06515	3,281,224.32	213,769.96	44,891,692.19
24	164	472.69	-0.68	-0.0946134	0.06480	3,281,224.32	212,618.29	34,869,400.05
25	487	161.05	-0.89	-0.0946134	0.08445	3,281,224.32	277,115.13	134,955,067.32
26	122	469.19	-0.69	-0.0946134	0.06502	3,281,224.32	213,341.66	26,027,682.51
27	129	451.20	-0.70	-0.0946134	0.06615	3,281,224.32	217,065.78	28,001,486.11
28	56	271.29	-0.82	-0.0946134	0.07750	3,281,224.32	254,300.38	14,240,821.45
29	77	530.18	-0.65	-0.0946134	0.06117	3,281,224.32	200,719.58	15,455,407.80
30	63	530.18	-0.65	-0.0946134	0.06117	3,281,224.32	200,719.58	12,645,333.65
31	1,172	159.55	-0.89	-0.0946134	0.08455	3,281,224.32	277,426.99	325,144,433.82
32	332	467.12	-0.69	-0.0946134	0.06515	3,281,224.32	213,769.96	70,971,627.66

Table 4.7 (Continued)

No.	Number of Units	Distance to BTS station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 1,500 m	Price changed (economic rent) per unit	Economic rent of each project (Baht)
33	218	343.52	-0.77	-0.0946134	0.07295	3,281,224.32	239,351.76	52,178,684.60
34	107	1,085.47	-0.28	-0.0946134	0.02615	3,281,224.32	85,793.96	9,179,953.62
35	138	1,085.47	-0.28	-0.0946134	0.02615	3,281,224.32	85,793.96	11,839,566.36
36	262	73.45	-0.95	-0.0946134	0.08998	3,281,224.32	295,245.22	77,354,247.67
37	192	300.16	-0.80	-0.0946134	0.07568	3,281,224.32	248,325.78	47,678,550.70
38	149	358.34	-0.76	-0.0946134	0.07201	3,281,224.32	236,284.53	35,206,394.23
39	234	403.94	-0.73	-0.0946134	0.06913	3,281,224.32	226,845.74	53,081,904.06
40	376	177.52	-0.88	-0.0946134	0.08342	3,281,224.32	273,707.65	102,914,076.26
41	583	180.28	-0.88	-0.0946134	0.08324	3,281,224.32	273,135.68	159,238,099.51
42	226	719.13	-0.52	-0.0946134	0.04925	3,281,224.32	161,613.37	36,524,621.19
43	226	789.25	-0.47	-0.0946134	0.04483	3,281,224.32	147,100.60	33,244,735.51
44	226	746.71	-0.50	-0.0946134	0.04751	3,281,224.32	155,904.76	35,234,476.02
45	349	686.32	-0.54	-0.0946134	0.05132	3,281,224.32	168,402.55	58,772,491.41
46	423	153.71	-0.90	-0.0946134	0.08492	3,281,224.32	278,635.36	117,862,757.08
47	413	383.63	-0.74	-0.0946134	0.07042	3,281,224.32	231,049.13	95,423,290.61
48	779	833.00	-0.44	-0.0946134	0.04207	3,281,224.32	138,045.78	107,537,665.23
49	146	223.00	-0.85	-0.0946134	0.08055	3,281,224.32	264,294.55	38,587,004.41
50	810	692.30	-0.54	-0.0946134	0.05095	3,281,224.32	167,165.79	135,404,286.60
51	218	223.00	-0.85	-0.0946134	0.08055	3,281,224.32	264,294.55	57,616,212.06
52	940	250.84	-0.83	-0.0946134	0.07879	3,281,224.32	258,532.64	243,020,681.39
53	460	805.85	-0.46	-0.0946134	0.04378	3,281,224.32	143,664.97	66,085,884.73
54	79	266.17	-0.82	-0.0946134	0.07782	3,281,224.32	255,359.86	20,173,429.21
55	56	306.03	-0.80	-0.0946134	0.07531	3,281,224.32	247,109.83	13,838,150.32
56	56	271.29	-0.82	-0.0946134	0.07750	3,281,224.32	254,300.38	14,240,821.45
57	138	1,044.41	-0.30	-0.0946134	0.02874	3,281,224.32	94,291.27	13,012,195.54
58	74	270.00	-0.82	-0.0946134	0.07758	3,281,224.32	254,567.19	18,837,971.82
59	60	1,100.00	-0.27	-0.0946134	0.02523	3,281,224.32	82,786.08	4,967,164.62
				Total Value				***2,988,644,281.37***

Source: Form Calculation.

Table 4.8 illustrates the summaries of an estimated economic rent (or implicit price) from the condominium projects which are located within 1,500 meter from the sky train station. An average economic rent per condominium unit is

187,569.33 baht since a minimum value is 4,271.00 baht and maximum economic rent of unit is 299,082.25 baht. However, a total value of economic rent of the sky train station in term of condominium projects which are located within 1,500 meter from the station is 2,988,644.281.37 baht, a minimum value per condominium project is 128,129.97 baht since the maximum value per project is 325,144,433.82 baht and an average implicit price value of each condominium project is 50,654,987.82 baht. A minimum distance to the station is 54.92 meter while a maximum distance is 1,479.36 meter and an average distance to the sky train station is 593.72 meter. The total numbers of units of condominium project which are located within 1,500 meter from the sky train station are 14,624.00 units, an average unit for each project is 247.86 units since a maximum unit is 1,172.00 units and a minimum unit is 30.00 units. An average size of land of each condominium project which is located within 1,500 meter of the sky train station is 7,889.37 square meter while a minimum size is 401.80 square meter and a maximum is 37,830.03 square meter.

Table 4.8 Summary of an Estimated Economic Rent of Condominium Projects Located within 1,500 meter of the Sky Train Station

	Economic rent per unit (Baht)	Economic rent per condominium project (Baht)	Distance to sky train station (m)	Units	Land (sqm.)
minimum	4,271.00	128,129.97	54.92	30.00	401.80
maximum	299,082.25	325,144,433.82	1,479.36	1,172.00	37,830.03
average	187,569.33	50,654,987.82	593.72	247.86	7,889.37
Total value	-	**2,988,644,281.37**	-	**14,624.00**	**465,472.63**

Source: Form Calculation.

3) A change of the economic rents of condominium unit at each distance changes when compare with the boundary area (2,000 meters from the sky train station).

By using the equation (4.5), the estimated condominium unit's price for condominium project located within the 2,000 meter boundary area is 3,193,118.55 baht. The number of condominium projects (with construction completed in 2013) located within that area is 69 condominiums which include a total amount of room unit is 16,451.00 units. The total economic rents of the condominium projects are 3,378,377,226.87 baht, or around 3,378 million baht. The total value implies to the unearned gain (or the economic rent) that belong to an individual whose property locates within 2,000 of the sky train station. The details are shown on the Table 4.9.

Table 4.9 Economic Rents of Condominium Projects Located within 2,000 meter of the Sky Train Station (The Light Green Lines Extensions, On Nut to Bearing Station)

No.	Number of Units	Distance to sky train station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 2,000 m	Price changed (economic rent) per unit	Economic rent of each project (Baht)
1	198	1,757.52	-0.12	-0.0946134	0.01	3,193,118.55	36,627.60	7,252,264.34
2	79	326.75	-0.84	-0.0946134	0.08	3,193,118.55	252,754.61	19,967,614.02
3	45	750.64	-0.62	-0.0946134	0.06	3,193,118.55	188,722.67	8,492,520.28
4	250	1,290.47	-0.35	-0.0946134	0.03	3,193,118.55	107,179.08	26,794,769.55
5	96	969.19	-0.52	-0.0946134	0.05	3,193,118.55	155,710.21	14,948,180.29
6	72	1,133.25	-0.43	-0.0946134	0.04	3,193,118.55	130,928.21	9,426,830.85
7	205	1,757.52	-0.12	-0.0946134	0.01	3,193,118.55	36,627.60	7,508,657.52
8	66	929.45	-0.54	-0.0946134	0.05	3,193,118.55	161,713.60	10,673,097.81
9	90	1,365.17	-0.32	-0.0946134	0.03	3,193,118.55	95,895.24	8,630,571.92
10	79	54.92	-0.97	-0.0946134	0.09	3,193,118.55	293,816.53	23,211,506.26
11	78	1,707.08	-0.15	-0.0946134	0.01	3,193,118.55	44,247.42	3,451,298.90
12	45	1,843.57	-0.08	-0.0946134	0.01	3,193,118.55	23,629.08	1,063,308.68
13	105	558.88	-0.72	-0.0946134	0.07	3,193,118.55	217,689.41	22,857,387.93
14	143	316.67	-0.84	-0.0946134	0.08	3,193,118.55	254,277.36	36,361,663.17
15	162	1,543.38	-0.23	-0.0946134	0.02	3,193,118.55	68,974.55	11,173,877.50
16	350	895.15	-0.55	-0.0946134	0.05	3,193,118.55	166,893.71	58,412,798.87
17	127	888.54	-0.56	-0.0946134	0.05	3,193,118.55	167,892.09	21,322,295.18
18	368	762.90	-0.62	-0.0946134	0.06	3,193,118.55	186,871.31	68,768,643.45
19	100	1,643.59	-0.18	-0.0946134	0.02	3,193,118.55	53,838.48	5,383,847.81
20	77	504.35	-0.75	-0.0946134	0.07	3,193,118.55	225,926.82	17,396,365.02

Table 4.9 (Continued)

No.	Number of Units	Distance to sky train station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 2,000 m	Price changed (economic rent) per unit	Economic rent of each project (Baht)
21	135	1,077.67	-0.46	-0.0946134	0.04	3,193,118.55	139,324.11	18,808,755.08
22	161	1,072.11	-0.46	-0.0946134	0.04	3,193,118.55	140,163.60	22,566,340.02
23	154	576.65	-0.71	-0.0946134	0.07	3,193,118.55	215,005.07	33,110,781.20
24	199	530.82	-0.73	-0.0946134	0.07	3,193,118.55	221,928.91	44,163,853.61
25	198	530.05	-0.73	-0.0946134	0.07	3,193,118.55	222,044.00	43,964,711.84
26	879	467.12	-0.77	-0.0946134	0.07	3,193,118.55	231,550.39	203,532,793.66
27	163	1,517.18	-0.24	-0.0946134	0.02	3,193,118.55	72,932.10	11,887,933.01
28	30	1,479.36	-0.26	-0.0946134	0.02	3,193,118.55	78,645.19	2,359,355.63
29	171	796.78	-0.60	-0.0946134	0.06	3,193,118.55	181,754.15	31,079,959.93
30	210	467.12	-0.77	-0.0946134	0.07	3,193,118.55	231,550.39	48,625,582.10
31	164	472.69	-0.76	-0.0946134	0.07	3,193,118.55	230,709.83	37,836,412.39
32	487	161.05	-0.92	-0.0946134	0.09	3,193,118.55	277,783.58	135,280,603.81
33	122	469.19	-0.77	-0.0946134	0.07	3,193,118.55	231,237.79	28,211,010.28
34	129	451.20	-0.77	-0.0946134	0.07	3,193,118.55	233,955.88	30,180,308.96
35	56	271.29	-0.86	-0.0946134	0.08	3,193,118.55	261,131.98	14,623,390.85
36	77	530.18	-0.73	-0.0946134	0.07	3,193,118.55	222,025.42	17,095,957.48
37	63	530.18	-0.73	-0.0946134	0.07	3,193,118.55	222,025.42	13,987,601.58
38	1,172	159.55	-0.92	-0.0946134	0.09	3,193,118.55	278,011.20	325,829,123.73
39	332	467.12	-0.77	-0.0946134	0.07	3,193,118.55	231,550.39	76,874,729.80
40	218	343.52	-0.83	-0.0946134	0.08	3,193,118.55	250,221.56	54,548,300.05
41	107	1,085.47	-0.46	-0.0946134	0.04	3,193,118.55	138,145.65	14,781,584.35
42	138	1,085.47	-0.46	-0.0946134	0.04	3,193,118.55	138,145.65	19,064,099.44
43	270	1,636.97	-0.18	-0.0946134	0.02	3,193,118.55	54,838.54	14,806,405.44
44	262	73.45	-0.96	-0.0946134	0.09	3,193,118.55	291,016.03	76,246,201.12
45	192	300.16	-0.85	-0.0946134	0.08	3,193,118.55	256,771.35	49,300,099.39
46	149	358.34	-0.82	-0.0946134	0.08	3,193,118.55	247,982.90	36,949,452.16
47	234	403.94	-0.80	-0.0946134	0.08	3,193,118.55	241,093.90	56,415,972.27
48	376	177.52	-0.91	-0.0946134	0.09	3,193,118.55	275,296.59	103,511,519.29
49	583	180.28	-0.91	-0.0946134	0.09	3,193,118.55	274,879.13	160,254,534.48
50	226	719.13	-0.64	-0.0946134	0.06	3,193,118.55	193,483.31	43,727,227.31

Table 4.9 (Continued)

No.	Number of Units	Distance to sky train station (m)	Change in distance when compare with the boundary (%)	Elasticity at 1 %	Elasticity at each change	Estimated price at 2,000 m	Price changed (economic rent) per unit	Economic rent of each project (Baht)
51	226	789.25	-0.61	-0.0946134	0.06	3,193,118.55	182,891.00	41,333,365.42
52	226	746.71	-0.63	-0.0946134	0.06	3,193,118.55	189,316.81	42,785,600.18
53	349	686.32	-0.66	-0.0946134	0.06	3,193,118.55	198,438.47	69,255,026.53
54	423	153.71	-0.92	-0.0946134	0.09	3,193,118.55	278,893.14	117,971,797.80
55	413	383.63	-0.81	-0.0946134	0.08	3,193,118.55	244,161.79	100,838,818.30
56	779	833.00	-0.58	-0.0946134	0.06	3,193,118.55	176,282.24	137,323,862.42
57	146	223.00	-0.89	-0.0946134	0.08	3,193,118.55	268,426.34	39,190,245.13
58	336	1,700.00	-0.15	-0.0946134	0.01	3,193,118.55	45,316.77	15,226,434.84
59	810	692.30	-0.65	-0.0946134	0.06	3,193,118.55	197,535.80	160,003,999.66
60	218	223.00	-0.89	-0.0946134	0.08	3,193,118.55	268,426.34	58,516,941.36
61	940	250.84	-0.87	-0.0946134	0.08	3,193,118.55	264,220.94	248,367,683.80
62	460	805.85	-0.60	-0.0946134	0.06	3,193,118.55	180,383.46	82,976,392.40
63	79	266.17	-0.87	-0.0946134	0.08	3,193,118.55	261,905.25	20,690,515.01
64	56	306.03	-0.85	-0.0946134	0.08	3,193,118.55	255,883.87	14,329,496.74
65	56	271.29	-0.86	-0.0946134	0.08	3,193,118.55	261,131.98	14,623,390.85
66	138	1,044.41	-0.48	-0.0946134	0.05	3,193,118.55	144,347.51	19,919,956.20
67	270	1,636.97	-0.18	-0.0946134	0.02	3,193,118.55	54,838.54	14,806,405.44
68	74	270.00	-0.87	-0.0946134	0.08	3,193,118.55	261,326.71	19,338,176.48
69	60	1,100.00	-0.45	-0.0946134	0.04	3,193,118.55	135,950.31	8,157,018.67
				Total Value				***3,378,377,226.87***

Source: Form Calculation.

Table 4.10 illustrates and summarizes the estimated economic rent (or implicit price) of condominium project located within the 2,000 meters from the sky train station. An average implicit price per condominium unit is 188,769.52 baht since the minimum value is 23,629.08 baht and maximum implicit price of unit is 293,816.53 baht. However, the total economic rents of condominium projects located within 2,000 meters of the sky train station is 3,378,377,226.87 baht, a minimum value per condominium project is 1,063,308.68 baht since the maximum value per condominium project is 325,829,123.73 baht and an average economic rent value of each project is 48,961,988.80 baht. A minimum distance to the station is 54.92 meter while a maximum distance is 1,843.57 meter and an average distance to the sky train station is 750.33 meter. The total number of units of condominium projects which are located within 2,000 meter from the sky train station is 16,451.00 units; the average unit for each project is 238.42 units since a maximum unit is 1,172.00 units and a minimum unit is 30.00 units. The total quantity of condominium land which is located within 2,000 meter of the sky train station is 506,401.07 square meter, an average land size of each condominium is 7,339.15 square meter while a minimum size is 401.80 square meter and a maximum is 37,830.03 square meter.

Table 4.10 Summary of an Estimated Economic Rents of Condominium Projects Located within 2,000 meter of the Sky Train Station

	Economic rent per unit (Baht)	**Economic rent per condominium project (Baht)**	**Distance to sky train station (m)**	**Units**	**Land (sqm.)**
minimum	23,629.08	1,063,308.68	54.92	30.00	401.80
maximum	293,816.53	325,829,123.73	1,843.57	1,172.00	37,830.03
average	188,769.52	48,961,988.80	750.33	238.42	7,339.15
Total value	**-**	**3,378,377,226.87**	**-**	**16,451.00**	**506,401.07**

Source: Form Calculation

4.3.2.2 Estimation of a Betterment Tax Rate

This study will apply the concept of property value capture taxation to the context of Thailand by using properties around the sky train station (The Light Green Lines Extensions, On Nut to Bearing station) to be a case study. The estimated results from 4.3.2.1 demonstrate the positive impact and un-earned gains from a public transportation project to individual property owners in close proximity to the sky train line. The results confirm that this is the right time for the Thai government to reconsider new financial mechanisms to capture a portion of the unearned gains to offset public expenditures for public infrastructure projects through a property value taxation or betterment tax.

The Light Green lines Extensions (On Nut to Bearing Station) was built and is operated by the Bangkok Mass Transit System Public Company Limited (BTSC) (2016) from 1st September 2006 to 11th August 2011. An additional 5.25 kilometers extension from Sukhumvit Line, On Nut to Bearing was opened on 12th August 2011. From feasibility study of survey and design of the Bangkok mass rapid transit system by the Liewphairoj (1999), the evaluated initial cost of invest a 5.25 kilometer extension was 8,541 million baht (the details are shown on Table 4.11). Using the initial cost of investment (8,541 million baht) and an interest rate of 7 percent, we can calculate the cost of the initial investment in 2013 values to be 13,714.98 billion baht (please note that our estimate is based on properties with construction completion dates in the year 2013).

Table 4.11 An Estimated Initial Cost of the Light Green Lines Extensions, On Nut to Bearing Station

Items	**Value (million baht)**	**Portion (%)**
Electrical system and machinery cost	4,349	51
Land cost	495	6
Construction cost	2,283	27
Environmental cost (civil)	114	1
Construction consultant cost	137	2
Environmental cost (others)	343	4
Total	7,721	90
Financial reporting	820	10
Total cost	**8,541**	**100**

Source: Liewphairoj, 1999.

1) Tax Mapping

In order to estimate the betterment tax rate which might be collected from the property owners who live along the Light Green Lines Extensions (On Nut to Bearing station), a tax map must be drawn in order to calculate the total space of each assessment area. After establishing the tax map, we will use the space data to compute an appropriate tax rate by applying the land use in Bangkok (determined by the 2009 survey by the Department of City Planning) to calculate condominium space in term of percentage of a total land use in a targeted area. A tax map for each zone is shown below.

(1) The total space of an assessment area which located within 1,000 meter of the sky train station.

The total area of an assessment zone which located within 1,000 meter of the Light Green Lines Extensions (On Nut to Bearing station) is approximately 12,071,428.57 square meters. The tax mapping will be shown in figure 4.2.

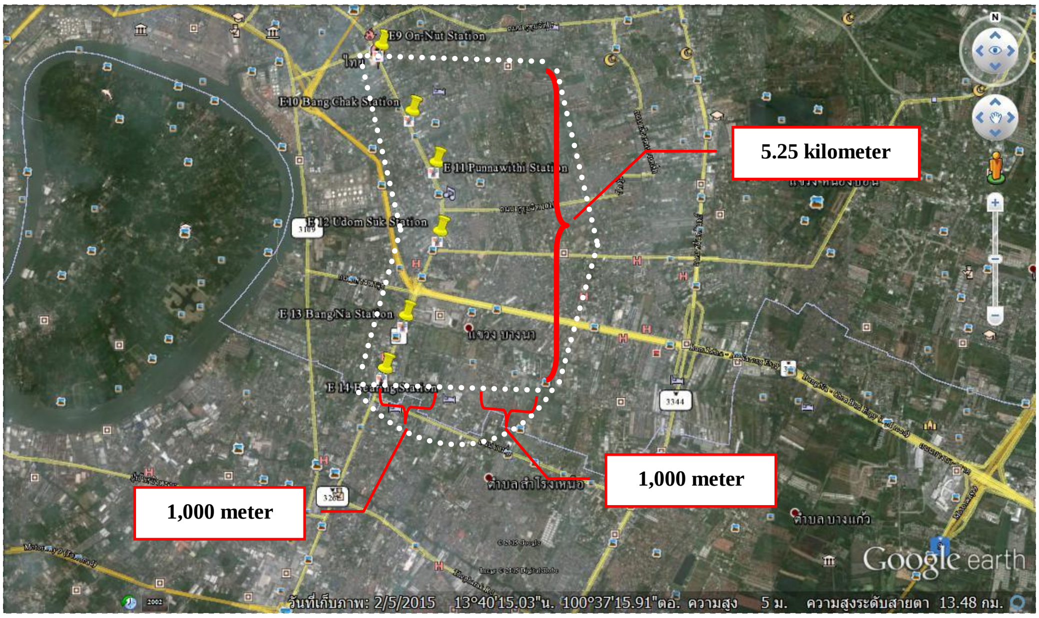

Figure 4.3 The Tax Mapping of an Assessment Area Located within 1,000 meter of the Light Green Lines Extensions (On Nut to Bearing station)

(2) The total space of an assessment area which located within 1,500 meter of the sky train station

The total space of an assessment zone which is located within 1,500 meter from the Light Green Lines Extensions (On Nut to Bearing station) is approximately 19,285,714.29 square meters. The tax mapping will be shown in figure 4.3.

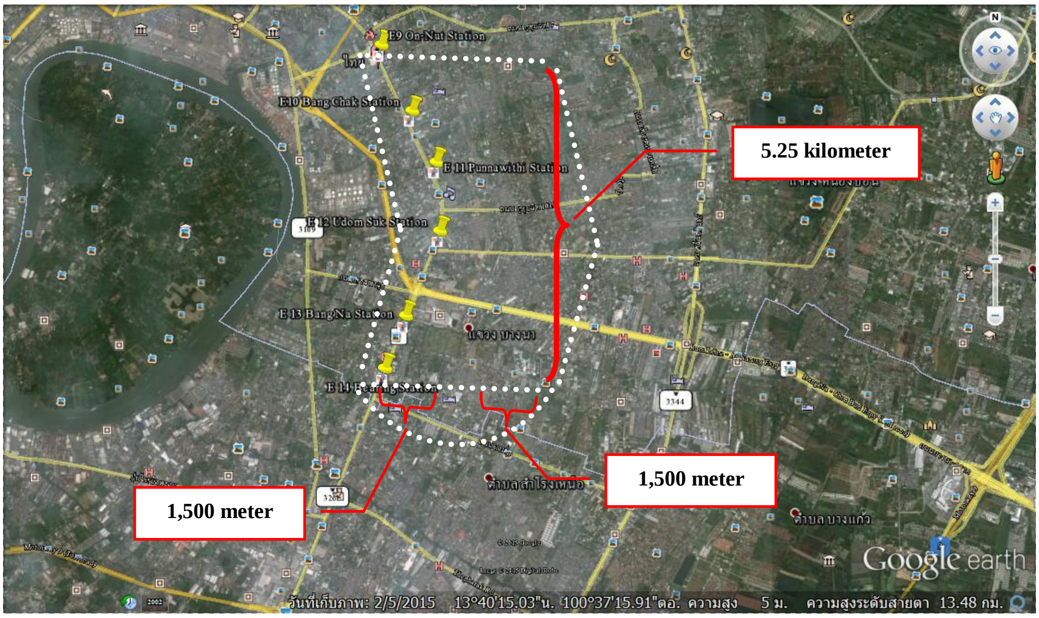

Figure 4.4 The Tax Mapping of an Assessment Area Located within 1,500 meter of the Light Green Lines Extensions (On Nut to Bearing station)

(3) The total space of an assessment area which located within 2,000 meter of the sky train station

The total space of an assessment zone which is located within 2,000 meter of the Light Green Lines Extensions (On Nut to Bearing station) is approximately 27,285,714.29 square meters. The tax mapping will be shown in figure 4.4.

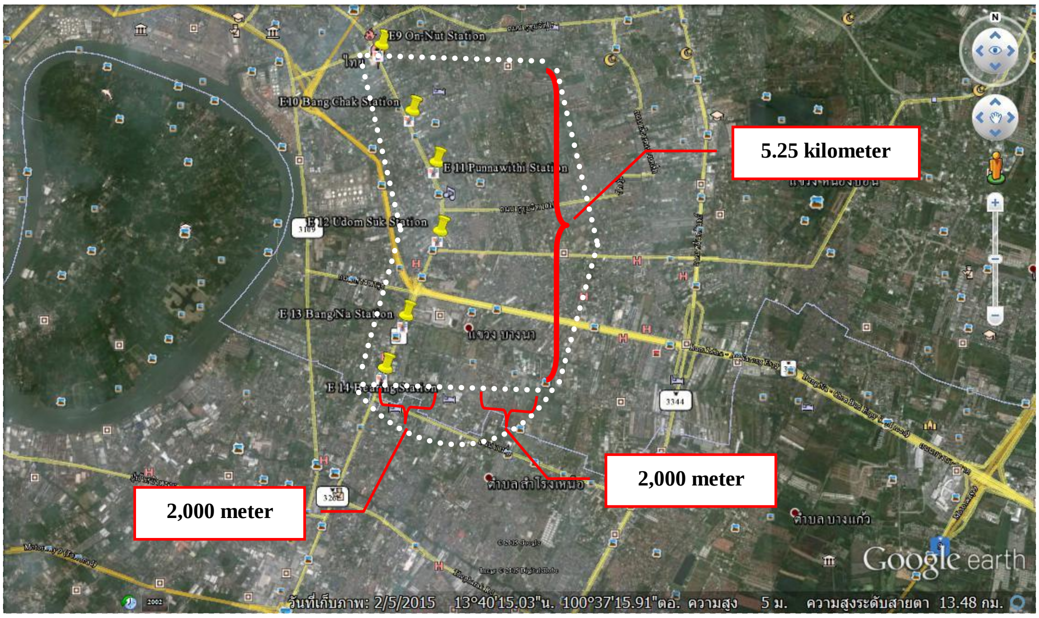

Figure 4.5 The Tax Mapping of an Assessment Area Located within 2,000 meter of the Light Green Lines Extensions (On Nut to Bearing station)

2) Estimated Betterment Tax

In order to promote fairness for the condominium owners, we cannot assign the total investment cost to them because there are other property owners, such as landowners, dethatch houses, commercial areas and so on, who benefit from the BTS lines. Therefore, it is necessary to calculate the percentage of condominium area versus total land use and apply that percentage number to compute the portion of an investment cost that will be collect from the condominium owners. It implies that the portion of land use is same as the portion of investment cost. Thus, the tax burden and the betterment tax rate for the property owners can be calculated. An importance assumption for this analysis is the percentage of land use in each area is indifferent. Thus, we can apply the land use in Bangkok using the latest 2009 survey data from the Department of City Panning. Table 4.12 illustrates the detail about the percentage of land use in various aspects. Base on the data in 2009; the non-tax area contains six areas as follow (a) road space (7.47% of total land use), (b) a government compound area (2.44% of total land use), (c) an educational institution area (1.24% of total land use), (d) a religious institution area (0.57% of total land use), (e) a recreation area (1.42% of total land use), and (g) a water resource area (5.91% of total land use) respectively. Thus, the available area which can be used for calculating the betterment tax is the entire area minus the non-tax area. The portion of condominium space in the three assessment areas is 4.32%, 2.98%, and 2.29% respectively when compare to the whole available areas. Therefore, the amounts of betterment tax which will be issued in three areas are; 4.32%, 2.98%, and 2.29%, these percentages will be applied to the initial cost of investment. The tax burdens for condominiums locate within 1,000 meter from the BTS station is 592,704,431.85 baht. While, condominiums locate within 1,500 meter from the BTS station bear the tax burden 408,918,475.90 baht. The tax burden for condominiums locate within 2,000 meter from the BTS station is equal to 314,439,864.17 baht.

Table 4.12 Land Use in Bangkok: the Latest Survey in 2009

Land use in Bangkok	**Distance from condominium project to the Light Green Lines Extension station**		
	Within 1,000 meter	**Within 1,500 meter**	**Within 2,000 meter**
Entire area (sqm.)	12,071,428.57	19,285,714.29	27,285,714.29
Non- tax area:			
(a) Road space = 7.47%	901,735.71	1,440,642.86	2,038,242.86
(b) Government compound area = 2.44%	294,542.86	470,571.43	665,771.43
(c) Educational institution area = 1.24%	149,685.71	239,142.86	338,342.86
(d) Religious institution area = 0.57%	68,807.14	109,928.57	155,528.57
(e) Recreation area = 1.42%	171,414.29	273,857.14	387,457.14
(f) Water resource area = 5.91%	713,421.43	1,139,785.71	1,612,585.71
(g) Total area (sqm.) = (a) + (b) +(c) + (d) + (e) + (f)	2,299,607.14	3,673,928.57	5,197,928.57
(h) Available space is use for calculating betterment tax (sqm.) = Entire area – (g)	**9,771,821.43**	**15,611,785.71**	**22,087,785.71**
(i) Condominium area (sqm)	422,297.52	465,472.63	506,401.07
(j) Portion of condominium area (% of available space ,(h))	**4.32**	**2.98**	**2.29**
Tax burden for condominium (baht)	**592,704,431.85**	**408,918,475.90**	**314,439,864.17**

Source: From the Department of City Planning

From the Table 4.12 we can estimate the betterment tax to an individual whose property is located within the assessment area as follow (the details are in Table 4.13),

(1) Condominium project located within 1,000 meter of the sky train station

The Portion of condominium area; which is calculated from the land use of Bangkok (Table 4.12), is 4.32 percent of an available space. Therefore, the total tax burden for 49 condominium projects which are located within 1,000 meter from the Light Green Lines Extensions (On Nut to Bearing station) is also 4.32 percent of an initial cost of construction; or equal to 592,704,431.85 baht. When compare with the total value of economic rents which belong to the condominium owners in the 1,000 meter assessment area; we found that the total tax burden is only 25.12 percent of economic rent value. It should be noted that the portion of betterment tax in the 1,000 assessment area which will issue to property owner might be highest among the other assessment area because condominium projects are located concentration in this area. While, the average betterment tax per condominium unit is equal to 42,516.07 baht, maximum betterment tax per unit is equal to 76,597.90 baht and minimum betterment tax per unit is equal to 2,497.26 baht respectively (Table 4.13).

(2) Condominium project located within 1,500 meter of the sky train station

The portion of condominium area located within 1,500 meter assessment area; which is calculated from the land use of Bangkok (Table 4.12), is 2.98 percent of an available space. Therefore, the total tax burden for 59 condominium projects which are located within 1,500 meter of the Light Green Lines Extensions (On Nut to Bearing station) is equal to 2.98 percent of an initial cost of construction; or equal to 408,918,475.90 baht. When compare with the economic rent value that occur to condominium project located within in the 1,500 assessment area of the Light Green Lines Extensions (On Nut to Bearing station); we found that the total tax burden, 408,918,475.90 baht, is equal to 13.68 percent of the economic rent value. While, the average betterment tax per condominium unit is equal to 25,664.00

baht, maximum betterment tax per unit is equal to 40,921.65 baht and minimum betterment tax per unit is equal to 584.38 baht respectively (Table 4.13).

(3) Condominium located within 2,000 meter of the sky train station

The portion of condominium space located within 2,000 meter of the Light Green Lines Extensions (On Nut to Bearing station) is 2.29 percent of an available space (Table 4.12). Therefore, the total tax burden for 69 condominium projects which are located within 2,000 meter assessment area is equal to 2.29 percent of an initial cost of construction; or equal to 314,439,864.17 baht. When compare with the economic rent values that occur to condominium projects located within in the 2,000 meter assessment area; we found that the total tax burden is equal to 9.31 percent of the increment value. While, the average betterment tax per condominium unit is equal to 17,569.58 baht, maximum betterment tax per unit is equal to 27,346.75 baht and minimum betterment tax per room unit is equal to 2,199.26 baht respectively (Table 4.13).

Table 4.13 Estimated Betterment Tax in Each Assessment Area

Distance from condominium project to the sky train station	Total condomi-nium projects	Total tax burden (baht)	Percent of economic rent	Average betterment tax per units (baht)	Minimum betterment tax per units (baht)	Maximum betterment tax per units (baht)	Average betterment tax per sqm (baht/sqm)
Within 1,000 meter	49	592,704,431.85	25.12%	42,516.07	2,497.26	76.597.90	928.52
Within 1,500 meter	59	408,918,475.90	13.68%	25,664.00	584.38	40,921.65	560.48
Within 2,000 meter	69	314,439,864.17	9.31%	17,569.58	2,199.26	27,346.75	383.71

Source: Form Calculation.

However, in order to provide an opportunity to the taxpayer, especially an individual who has a financial constraint, we can classify the betterment tax into two options: a one-time charge, or an annual charge. The annual betterment charge is calculated by using an average inflation rate of Thailand from year 2011 to 2014, which is 3.89%, to be a discount rate. The details are as follow (Table 4.14),

(4) Condominium project located within 1,000 meter of the sky train station

The annual betterment charge is divided into two aspects; ten years plan, and fifteen years plan. For property owners whose condominium units are located within 1,000 meter of Light Green Lines Extensions (On Nut to Bearing station); an average burden in ten years annual charge is 5,213.18 baht per unit while a minimum burden is 306.21 baht per unit and a maximum charge is 9,392.18 baht. For 15 years annual tax; a minimum charge is 222.88 baht per unit while a maximum tax is 6,836.41 baht and an average charge per unit is 3,794.59 baht. While, an average one-time charge for property owner in that area is 42,516.07 baht per room (or 12,096,009.42 bath per condominium project), a minimum one- time charge is 2,497.26 baht per unit, and a maximum one-time tax is 76,597.90 baht per unit (or 79,833,801.87 baht per condominium project) respectively.

(5) Condominium project located within 1,500 meter of the sky train station

For condominium project which are located within 1,500 meter of Light Green Lines Extensions (On Nut to Bearing station); the average ten years betterment charge is 3,146.84 baht per unit, a minimum charge is only 71.65 baht per unit, and a maximum betterment tax per room unit is 5,017.68 baht respectively. For the fifteen years charge; a minimum burden per unit is only 52.16 baht, a maximum charge is 3,652.29 baht per unit, and an average betterment tax is 2,290.53 baht respectively. When consider a one-time charge, a minimum charge per condominium unit is 584.38 baht (or only 17,531.26 baht per condominium project), a maximum tax is 40,921.65 baht per unit (or 44,487,584.94 baht per condominium project), and an average charge per unit is 25,664.00 baht respectively.

(6) Condominium project located within 2,000 meter of the sky train station

For property owner whose condominium locates within 2,000 meter of Light Green Lines Extensions (On Nut to Bearing station), an average burden in ten years annual charge is 2,154.32 baht per room unit while a minimum charge per unit is only 269.67 baht, and a maximum burden is 3,353.17 baht per unit. For the fifteen years annual charge, an average tax per unit of condominium unit is

1,568.10 baht while a minimum burden per unit is 196.29 baht and a maximum charge per unit is 2,440.72 baht respectively. In the case of one-time charge, we found that a minimum charge per unit is only 2,199.26 baht while a maximum charge is 27,346.75 baht per unit and an average charge is 17,569.58 baht per unit (or 4,557,099.50 baht per condominium project) respectively.

Table 4.14 The One-Time Charge and Annual Charge in Each Assessment Area

	Condo's unit	Distance to sky train station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condo	Tax burden per unit	Tax burden per condo	Tax burden per unit	Tax burden per condo
Condominium is located within 1,000 meter from the Light Green Lines Extensions (On Nut to Bearing station)								
Min	45	54.92	2,497.26	239,736.92	306.21	29,395.76	222.88	21,396.68
Max	1,172	969.19	76,597.90	79,833,801.87	9,392.18	9,788,960.26	6,836.41	7,125,221.09
Average	274	475.43	42,516.07	12,096,009.42	5,213.18	1,483,173.20	3,794.59	1,079,577.06
Condominium is located within 1,500 meter from the Light Green Lines Extensions (On Nut to Bearing station)								
Min	30	54.92	584.38	17,531.26	71.65	2,149.63	52.16	1,564.68
Max	1,172	1,479.36	40,921.65	44,487,584.94	5,017.68	5,454,922.49	3,652.29	3,970,547.20
Average	248	593.72	25,664.00	6,930,821.62	3,146.84	849,834.73	2,290.53	618,580.54
Condominium is located within 2,000 meter from the Light Green Lines Extensions (On Nut to Bearing station)								
Min	30	54.92	2,199.26	98,966.64	269.67	12,134.97	196.29	8,832.84
Max	1,172	1,843.57	27,346.75	30,326,295.45	3,353.17	3,718,511.38	2,440.72	2,706,642.49
Average	238	750.33	17,569.58	4,557,099.50	2,154.32	558,776.67	1,568.10	406,724.23

Source: Form Calculation.

CHAPTER 5

CONCLUSION AND POLICY IMPLICATION

5.1 Conclusion

The main objective of this study is to estimate an appropriate betterment tax rate for refinancing a public transport schemes through property value creation. The scope of this study focuses on the impact of the Light Green Lines Extensions (On Nut to Barring Station) based on the value creation of condominiums located in proximity to the line. The datasets used in this research have been collected from two sources. First, the data on market sale price and structural characteristics of the condominiums was obtained from property owners and brokers of the condominiums by interview and website search for the period from December 2013 to August 2014. Four Hundred forty-one (441) condominium units were randomly selected for our survey and were used to estimate the impact of the sky train station and other factors on property values. We have applied the concept of Hedonic Pricing Method (HPM) to estimate the implicit price of the Light Green Lines Extensions and other factors by using two difference type of the functional forms; (i) log-linear, and (ii) linear Box-Cox functional form.

The HPM results demonstrated that the factors which provided a positive effect to the residential property prices and were significant to all functional forms consisted of seven factors including: 1) the number of condominium's stories (HIGHT), 2) the number of condominium’s building (NOBUILD), 3) the parcel size of the condominium project in square meters (SQM_AREA), 4) the green environmental such as a park around the dwelling (GREEN_ENVI), 5) the size of condominium unit in square meter (LOTSIZE), 6) the new room type (NEWROOM), and 7) the fully furnished room (FUR). While, the positive impact factors which significant in some functional forms were: 1) the type of room, DUPPH, had a significant impact in RHBC model and UBC model, 2) the number of bedrooms, BEDROOM, had a significant effect in log-linear model, RHBC model, and UBC model. The number of bathrooms (BATH) had has a significant positive impact only one model that is RHBC model. But, the location of the unit (RFLOOR) in the condominium structure was insignificant for all of functional forms. For the factors which provided a negative effect to the resident condominium price and significant for all functional forms consisted of five factors including: 1) the age of condominiums; age was computed from the completed year (AGE), 2) the number of condominium's unit (UNIT), 3) the presence of a swimming pool (POOL), 4) the distance of the residential property to the nearest main road (MAINROAD_DIST), and the distance of the dwelling to the nearest sky train station (BTS_DIST). While, the distance from the residential condominium to the nearest shopping malls had a significant negative effect on the value of property in three functional forms; double-log model, RHBC model, and UBC model. However, the distance from the condominium to the central business district (CBD_DIST) had a significant negative impact on the property price in RHBC model.

The empirical results from all functional forms indicated that accessibility to the nearest sky train station provided a negative sign on residential property price. It implied that if a condominium is located close to a station, the price of condominium's room will be higher; if other things being equal. Average implicit price from every functional form was not significantly different; the estimated implicit price ranged from 150.46 to 195.04 baht for every meter closer to the sky train station. Therefore, condominiums located directly adjacent to the sky train station were roughly 150,460 to 195,040 baht more than an identical condominium located 1,000 meter away when considering the average value. However, when considering the elasticity of the condominium unit price with respect to the distance to the nearest sky train station (BTS_DIST), the result is roughly -0.09 which is similar to the result of Saksith Chalermpong (2007).

The total amount of the implicit price (or economic rent) of condominiums located within 1,000 meter, 1,500 meter, and 2,000 meter from the sky train station; were 2,359,072,495.61 baht, 2,988,644,281.37 baht, and 3,378,377,226.87 baht respectively. While, the number of condominium projects in each area was 49, 59, and 69 projects respectively.

The second step of our study was to estimate an appropriate betterment tax rate by applying the idea of the value capture strategy through the property value uplift. The total betterment tax burden from our estimation of 49 condominium projects, located within 1,000 meter from the Light Green Lines Extensions (On Nut to Barring Station), was equivalent to 592,704,431.85 baht or 25.12 percent of the economic rent. The total tax burden of the 59 condominium projects, located within 1,500 meter from the sky train station equaled 408,918,475.90 baht or 13.68 percent of the implicit price. Whereas, the total amount of tax burden for condominiums located within 2,000 meter from the sky train station, or 69 condominiums projects; was equal to 314,439,864.17 baht or 9.31 percent of the economic rent.

Therefore, the results from our study confirmed that there was an opportunity for Thai policymakers to establish a betterment tax in order to capture a portion of the windfall gains from the individual whose property was located adjacent to public transportation project because of a significant property value uplift was received from the public project.

5.2 Policy Implication

In developing countries like Thailand, financial resources for funding public projects, especially mega projects, mostly comes from the Government's budget and/or public debt. While the revenue sources that are used to fund the projects are from a "general tax" which is levied on all taxpayers of the entire country. It seems unfair for all citizens to subsidize public projects because some taxpayers do not have an opportunity to receive benefit from the schemes. In order to restore fairness to the taxpayer, policymakers should reconsider how to create new financial resources to reimburse the public investments based on the basic idea of "beneficiary pays principle" through the using of value capture concept.

The value capture strategy is particularly appropriate for public infrastructure projects like railways, main roads, mass transit systems, etc. where the public project produces a windfall "unearned-gains" for private property owners who never get involved in the project. Consequently, the beneficiaries should pay some portion of their windfall gains back to the country through the value capture tools. An important point to consider when evaluating an appropriate value capture mechanism for funding public infrastructure projects in each area depends upon who owns the land: private owner or public agency.

A joint development is more suitable if most of the land in that area belongs to local government. However, if most of the land is owned by the private sector, the public agency should confer with the landowners in order to define the appropriate policy to reimburse a public project (Reconnecting America's Center for Transit-Oriented Development, 2008). In the case of Thailand, lands and properties which are located in close proximity to a public infrastructure, especially transportation, are owned by individuals rather than public agencies. Hence, the taxes and fees strategy should be more proper than the non-taxes strategy to capture "economic rents" form the beneficiaries.

In the context of Thailand, a special assessment, or a betterment levy might be more suitable than other types of value capture taxation, such as land-value taxes (LVTs), and development impact fee (DIFs). In the case of land taxes, policymakers might face enormous obstacles when they attempt to introduce a conventional land taxes or property tax because politicians are major land-holders in Thailand. If a general property tax is imposed, the price of lands will depreciate, so a property tax initiative would generate a huge controversy from landowners who possess political power or influence (Brown and Smolka, 1997). For this reason, implementing land-value taxes or property taxes might never occur. Hence, the introduction of a special charge or betterment tax a for a selected area that received a direct benefit from a public investment might be more practical and acceptable mechanism than a conventional property tax because a betterment tax is levied on the incremental value or a portion of market value versus a property tax rate which levied on the total market value.

In the case of a development impact fee, this fee might be very useful and suitable, but only for a municipality which has a good zoning plan because the rate of fee is based upon the land use. Therefore, a DIF has little application because Thailand lacks a comprehensive zoning plan. When comparing the betterment tax to a tax increment financing (TIF), the TIF employs a similar idea regarding special assessment; the TIF uses the revenue from property tax to refinance the investment cost of a public infrastructure project; however, the TIF usually focuses on funding public infrastructure projects in an "undeveloped" area rather than concentrating on a specific public project like transportation. Moreover, the tax revenues which are generated in a TIF district are from the property tax; as we have previously discussed, there are political obstacles associated with implementing a property tax based initiative.

In addition, the objective of the special assessment or betterment tax is more easily accepted by the property owners because the property owners recognize that they received a direct and unique benefit from a public investment in a selected area. Moreover, the amount of betterment charge for each property is related to its proximity to the public infrastructure project; it implies that the closer the property is to the public betterment, the more benefit received by the property owner and the greater the betterment tax rate. Therefore, the betterment tax addresses the unfairness problem because it applies only to property owners who receive benefit from the public project. Consequently, the special assessment might be more practical and acceptable because the special charge is collected only on the incremental gain of market land value, which is different from a general land tax. Furthermore, betterment tax typically ranges from 30 to 60 percent of the incremental value (Walters, 2012); which leaves a portion of the remaining gain with the landowner or developer. In addition, policymakers can stipulate both the boundary of the tax zone and the timing of tax collection period to recover part or all of the public cost. So, the resident who is located in close proximity to the public investment, such as road, transit station, or highway, will not bear a burden from the value capture mechanism for an extended period of time. Establishing the tax collection period upfront also prevents the affected property owners from being overcharged. Furthermore, the concept of special assessment is not a new concept for Thailand. The concept was used in the Seventh National Economic and Social Development Plan of 1992-1996, which levied a special charge on landowners who benefitted from a public infrastructure project (part II, chapter 7), however the policymakers have never applied this concept as a general practice. The betterment tax concept effectively stretches public development funds by recouping a portion of the initial construction cost. The recouped portion can be returned to either the general budget or the development budget and used for additional public development projects. Therefore, it is the right time to implement the betterment tax concept to drive development in Thailand.

The results from our study has demonstrated the enormous impact of the sky train station (the Light Green Lines Extensions) on the property values located in proximity to the sky train station, even if the line is only 5.25 kilometers long. Therefore, in order to eliminate rent seeking from land speculation and restore equity in income distribution, we recommend that policymakers prepare new financial resources for refunding public infrastructure projects by enacting an upfront "betterment tax" on real estate developers for future real estate development projects within an assessment area.

We recommend collecting the betterment tax upfront from the real-estate developer, rather than the eventual condominium owner or resident, because the benefit of the improved accessibility to the sky train station is already in place and the value of improved accessibility is reflected in higher sales price to the eventual owner. In addition, unlike the developer, the eventual condominium owner does not receive any economic rent from the project. Lastly, the betterment tax collected from the developer, rather than the eventual condominium owner because it is the developer who receives the windfall gains from the project. Furthermore, imposing the betterment tax on the developer will reduce the tendency of a real estate bubble to form because the developer will consider their tax burden when negotiating the purchase price of the land with the land owner. The tax burden depends on price elasticity of supply and price elasticity of demand. It should be noted that, consistent with economic theory, the supply of land is perfectly inelastic; therefore, the value of land will decrease when the betterment tax is implement because the former land owner will bear all of the tax liability.

The tax process would begin when the developer registers the completed construction project with the Department of Lands. The taxing authority would levy the special charge at that time. In the case of a condominium project, the special charge would be based on the location of the project to the public infrastructure project and the number of units contained in the project.

However, we can offer options for the real estate developers in two ways:

5.2.1 A One-Time Tax

The first payment option allows the developer to pay the betterment tax with a one-time payment. The tax burden for each condominium depends upon three factors; a distance of the condominium project to the sky train station, the incremental value of the property, and the number of condominium unit.

As Table 4.13 shows, the average tax burden for a condominium located within 1,000 meter of the sky train station equals 25.12 percent of the incremental property value; which is 42,516.07 baht per unit of room, or equal to 12,096,009.42 baht per condominium project. For the condominium located within 1,500 meter, an average tax burden is equivalent to 13.68 percent of the implicit price; that is 25,664.00 baht per unit, or 6,930,821.62 baht per condominium project. While, the average tax burden for a sample located within 2,000 meter from the station is equal to 9.31 percent of the unearned gains generated from the transportation project; which is 17,569.58 baht per room, or 4,557,099.50 per condominium project. Therefore, the average tax burden range is from 9% to 25% which is consistent with worldwide betterment tax rates. It should be noted that the average number of condominium units in this study is 274 units for the 1,000 meter location, 248 units for the 1,500 meter location, and 238 units for the 2,000 meter location respectively.

5.2.2 An Annual Tax

The second payment option available offers a developer who faces a financial constraint to make an annual betterment tax payment. In this case, we need to separate a total amount of betterment charge of each condominium project into two categories; 10 years payment plan, or a 15 years payment plan. The annual betterment charge is calculated by using an average inflation rate of Thailand for the period of 2011 to 2014, or 3.89 percent, to be a discount rate.

The detail from Table 4.14 shows that for a condominium located within 1,000 meter; a ten year average payment is 5,213.18 baht per unit per year, or 1,483,173.20 baht per condominium project per year; while a fifteen year average tax is 3,794.59 baht per room per year, or 1,079,577.06 baht per condominium project per year. For a condominium project located within 1,500 meter; a ten year average payment is equivalent to 3,146.84 baht per unit per year, or 849,834.73 baht per condominium project per year; while a fifteen year average tax equals to 2,290.53 baht per unit per year, or 618,580.54 baht per condominium project per year. For a condominium projects locates within 2,000 meter; a ten year average payment is equal to 2,154.32 baht per unit per year, or 558,776.67 baht per condominium project per year; while a fifteen year average tax is equivalent to 1,568.10 baht per unit per year, or 406,724.23 baht per condominium project per year. It should be noted that the average number of condominium units in this study is 274 units for a 1,000 meter location, 248 units for a 1,500 meter location, and 238 units for a 2,000 meter location respectively.

The betterment tax not only generates income for funding public transportation projects but also discourages rent seeking on land speculation because this tax will increase the holding cost of the property owners and reduce their speculative gains. A concept behind the betterment tax is based on the concept of the "beneficiary pays principle"; it implies that those who received windfall gains from a public scheme should share some portion of their gains to support the investment cost. Therefore, to some degree, this type of tax does restore fairness in taxation. Moreover, revenue received from the betterment tax also help to reduce the sky train fares; thereby extending accessibility to low-income people.

5.3 Policy Recommendation

The successful implementation a betterment tax strategy in Thailand depends upon four issues.

5.3.1 The betterment tax rate, especially from the taxpayer's point of view, should not be excessively high; otherwise the taxpayer will oppose a public development project in their neighborhood; hence the local government and the stakeholder should have a joint voice in setting an appropriated tax rate including the assessment area.

5.3.2 A betterment tax is usually collected by the local government. Hence, an establishment of this kind of tax should be approved by majority voters in the affected municipality. In order to obtain social acceptance, the local government must actively work to promote the benefits, positive aspects and fairness of the tax.

5.3.3 Thai government should improve and provide a necessary technology for increasing an efficiency of land appraisal system, such as using Geographic Information System (GIS) for collecting real-estate data in a target zone, including encourage government officer to utilize a statistical model to systematically appraise value of land and property in order to support a betterment tax system.

5.3.4 To acquire a reliable data of land and property in Thailand, government needs to stimulate the Land Department to appraise a value of real-estate every year in order to obtain the real market price and other attributes of real-estate; therefore this data will be useful for public use.

5.4 Limitation and Further Research

5.4.1 Limitation of Study

5.4.1.1 For the accessibility measurement, we have applied the straight-line distance from a resident condominium to the nearest sky train station, main roads, shopping malls, and central business district using a geographic information system (GIS) via the Google Earth. Consequently, evaluated distances might deviate from a walking distance. Hence, our implicit price results might face an overestimation or underestimation problem.

5.4.1.2 In order to construct an accurate tax map, the specific land involved must be identified for the selected area; Pra Khanong district, and Bang Na district. However, in practice, we encountered some limitation in acquiring real land information for our study zone because dataset from the Department of City Planning does not provide a land use in each district but presents only an average land use of the whole space of Bangkok. Consequently, we have to estimate the land use of the target zone based on the land use data of Bangkok as the whole area. Therefore, an underestimation or an overestimation might occur. In addition, the latest version of land use survey occurred in year 2009; therefore it may be out of date and no longer a good representation of the land use in the current year.

5.4.2 Suggestion of a Further Research

The scope of this study is only on the impact of the Light Green Lines Extensions (On Nut to Bearing Station) on residential condominium value uplift.

While, the influence of the public transport is not only on condominium project but also effect on the other type of properties such as detached homes, unused land, and commercial buildings. Therefore, in order to extract the fullest benefit from the implementation of a betterment tax from all land holders located adjacent to the sky train station, we need to investigate windfall gains of all properties which capitalized from the public project.

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APPENDICES

APPENDIX A

HEDONIC PRICE MODEL: RESULTS

Hedonic Price Model: Results

Double Log Model

```
. . reg LNPRICE POOL FITNESS GREEN_ENVI DUPPH NEWROOM  FUR  lnAGE lnHIGHT lnNOBUILD lnUNIT lnSQM_AREA lnRFLOOR lnLOTSIZE lnBATH  lnBEDROOM lnC
> BD_DIST lnBTS_DIST lnMALL_DIST lnMAINROAD_DIST
```

Source	SS	df	MS
Model	123.648161	19	6.50779796
Residual	26.8463594	421	.063768075
Total	150.494521	440	.342033002

Number of obs =	441
F(19, 421) =	102.05
Prob > F =	0.0000
R-squared =	0.8216
Adj R-squared =	0.8136
Root MSE =	.25252

LNPRICE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
POOL	-.2206207	.0563572	-3.91	0.000	-.3313973	-.109844
FITNESS	.4345539	.0676947	6.42	0.000	.3014922	.5676156
GREEN_ENVI	.1677143	.0397367	4.22	0.000	.0896073	.2458213
DUPPH	.1381296	.0999312	1.38	0.168	-.0582967	.3345559
NEWROOM	.0575013	.0384551	1.50	0.136	-.0180866	.1330893
FUR	.1052889	.0324584	3.24	0.001	.0414882	.1690896
lnAGE	-.1369823	.0230538	-5.94	0.000	-.1822972	-.0916673
lnHIGHT	.2673993	.0511042	5.23	0.000	.1669481	.3678506
lnNOBUILD	.0960056	.0400076	2.40	0.017	.0173661	.174645
lnUNIT	-.2295469	.0332743	-6.90	0.000	-.2949513	-.1641424
lnSQM_AREA	.0523135	.0224713	2.33	0.020	.0081435	.0964834
lnRFLOOR	.0311061	.0235579	1.32	0.187	-.0151997	.0774119
lnLOTSIZE	.8210964	.0503785	16.30	0.000	.7220716	.9201212
lnBATH	.0887135	.062109	1.43	0.154	-.0333689	.2107959
lnBEDROOM	.0157214	.0030415	5.17	0.000	.009743	.0216998
lnCBD_DIST	-.0495664	.0722787	-0.69	0.493	-.1916385	.0925057
lnBTS_DIST	-.0946134	.0148421	-6.37	0.000	-.1237872	-.0654396
lnMALL_DIST	-.0554516	.0225004	-2.46	0.014	-.0996788	-.0112244
lnMAINROAD_DIST	-.0203152	.0070016	-2.90	0.004	-.0340777	-.0065528
_cons	13.1063	.5734729	22.85	0.000	11.97907	14.23353

```
. . vif
```

Variable	VIF	1/VIF
lnUNIT	7.01	0.142737
lnNOBUILD	4.73	0.211367
lnHIGHT	4.59	0.217969
lnSQM_AREA	3.35	0.298411
lnCBD_DIST	3.01	0.332218
lnAGE	2.73	0.366904
FITNESS	2.61	0.382585
lnBTS_DIST	2.41	0.415007
lnLOTSIZE	2.21	0.451598
lnMALL_DIST	2.03	0.492401
GREEN_ENVI	1.93	0.518631
lnMAINROAD~T	1.92	0.520106
POOL	1.77	0.564744
lnRFLOOR	1.74	0.575968
lnBATH	1.66	0.602043
NEWROOM	1.62	0.617462
FUR	1.43	0.700331
lnBEDROOM	1.42	0.702135
DUPPH	1.23	0.812946
Mean VIF	2.60	

```
. . hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of LNPRICE

         chi2(1)      =    10.54
         Prob > chi2  =   0.0012
```

```
. . estat ic
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	441	-388.6883	-8.591212	20	57.18242	138.9633

Note: N=Obs used in calculating BIC; see [R] BIC note

```
. . reg LNPRICE POOL FITNESS GREEN_ENVI DUPPH NEWROOM  FUR  lnAGE lnHIGHT lnNOBUILD lnUNIT lnSQM_AREA lnRFLOOR lnLOTSIZE lnBATH  lnBEDROOM lnC
> BD_DIST lnBTS_DIST lnMALL_DIST lnMAINROAD_DIST, robust

Linear regression                                      Number of obs =     441
                                                       F( 19,   421) =  136.60
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.8216
                                                       Root MSE      =  .25252
```

LNPRICE	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
POOL	-.2206207	.0567419	-3.89	0.000	-.3321535	-.1090879
FITNESS	.4345539	.0759818	5.72	0.000	.2852031	.5839048
GREEN_ENVI	.1677143	.0452747	3.70	0.000	.0787217	.2567069
DUPPH	.1381296	.0770906	1.79	0.074	-.0134008	.2896599
NEWROOM	.0575013	.0344628	1.67	0.096	-.0102392	.1252419
FUR	.1052889	.0295327	3.57	0.000	.0472391	.1633388
lnAGE	-.1369823	.025954	-5.28	0.000	-.1879978	-.0859668
lnHIGHT	.2673993	.0515009	5.19	0.000	.1661683	.3686303
lnNOBUILD	.0960056	.0430589	2.23	0.026	.0113683	.1806429
lnUNIT	-.2295469	.034686	-6.62	0.000	-.2977261	-.1613676
lnSQM_AREA	.0523135	.0256907	2.04	0.042	.0018154	.1028116
lnRFLOOR	.0311061	.0213716	1.46	0.146	-.0109022	.0731144
lnLOTSIZE	.8210964	.0695574	11.80	0.000	.6843734	.9578194
lnBATH	.0887135	.0631765	1.40	0.161	-.0354672	.2128942
lnBEDROOM	.0157214	.0037782	4.16	0.000	.0082949	.0231479
lnCBD_DIST	-.0495664	.0893385	-0.55	0.579	-.2251714	.1260386
lnBTS_DIST	-.0946134	.0146016	-6.48	0.000	-.1233145	-.0659123
lnMALL_DIST	-.0554516	.0225113	-2.46	0.014	-.0997001	-.011203
lnMAINROAD_DIST	-.0203152	.0055162	-3.68	0.000	-.031158	-.0094725
_cons	13.1063	.6257909	20.94	0.000	11.87624	14.33636

Box-Cox Transformation Form

1. RHBC Model

1.1 Box-Cox parameter

```
. . boxcox PRICE AGE  HIGHT NOBUILD UNIT SQM_AREA RFLOOR LOTSIZE  BATH MAINROAD_DIST   CBD_DIST BTS_DIST MALL_DIST , notrans ( BEDROOM POOL F:
> TNESS  GREEN_ENVI  DUPPH NEWROOM FUR) model (rhsonly) lrtest nolog nologlr

Fitting full model

Fitting comparison models for LR tests

                                                Number of obs   =        441
                                                LR chi2(20)     =     638.67
Log likelihood = -6627.5524                     Prob > chi2     =      0.000
```

PRICE	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/lambda	.0101826	.0662922	0.15	0.878	-.1197477	.1401129

Estimates of scale-variant parameters

	Coef.	chi2(df)	P>chi2(df)	df of chi2
Notrans				
BEDROOM	105682.5	1.032	0.310	1
POOL	-591566.5	10.381	0.001	1
FITNESS	406690.2	3.489	0.062	1
GREEN_ENVI	265647.4	4.307	0.038	1
DUPPH	1472748	20.614	0.000	1
NEWROOM	394066.4	9.993	0.002	1
FUR	320283.8	9.314	0.002	1
_cons	637150.4			
Trans				
AGE	-369745.9	24.705	0.000	1
HIGHT	779975	23.030	0.000	1
NOBUILD	419609.2	10.417	0.001	1
UNIT	-701287.3	45.484	0.000	1
SQM_AREA	216543.1	10.491	0.001	1
RFLOOR	104203.4	1.944	0.163	1
LOTSIZE	2132326	108.717	0.000	1
BATH	885631.6	18.118	0.000	1
MAINROAD_D~T	-85386.97	14.378	0.000	1
CBD_DIST	-465739.6	4.698	0.030	1
BTS_DIST	-199765.1	15.746	0.000	1
MALL_DIST	3734.591	0.003	0.956	1
/sigma	813844.9			

Test H0:	Restricted log likelihood	LR statistic chi2	P-value Prob > chi2
lambda = -1	-6665.1829	75.26	0.000
lambda = 0	-6627.5642	0.02	0.878
lambda = 1	-6657.8151	60.53	0.000

1.2 RHBC Result

```
. . reg PRICE POOL FITNESS GREEN_ENVI DUPPH NEWROOM FUR lnMAINROAD_DIST lnAGE lnHIGHT lnNOBUILD lnUNIT lnSQM_AREA lnRFLOOR lnLOTSIZE lnBATH lr
> CBD_DIST lnBTS_DIST lnMALL_DIST lnBEDROOM
```

Source	SS	df	MS
Model	9.5088e+14	19	5.0046e+13
Residual	2.9214e+14	421	6.9392e+11
Total	1.2430e+15	440	2.8250e+12

Number of obs =	441
F(19, 421) =	72.12
Prob > F =	0.0000
R-squared =	0.7650
Adj R-squared =	0.7544
Root MSE =	8.3e+05

PRICE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
POOL	-580181	185910.1	-3.12	0.002	-945608.6	-214753.4
FITNESS	396953.1	223309.8	1.78	0.076	-41987.91	835894.2
GREEN_ENVI	260763.9	131082.4	1.99	0.047	3106.362	518421.5
DUPPH	1498594	329651	4.55	0.000	850627	2146561
NEWROOM	402315.9	126855	3.17	0.002	152967.8	651663.9
FUR	311057.9	107073	2.91	0.004	100593.6	521522.2
lnMAINROAD_DIST	-84290.06	23096.8	-3.65	0.000	-129689.5	-38890.65
lnAGE	-375519.1	76049.48	-4.94	0.000	-525003.1	-226035.2
lnHIGHT	796914	168581.6	4.73	0.000	465547.6	1128280
lnNOBUILD	413282	131976.1	3.13	0.002	153867.9	672696.1
lnUNIT	-731059.6	109764.5	-6.66	0.000	-946814.4	-515304.8
lnSQM_AREA	234780.3	74127.92	3.17	0.002	89073.41	380487.3
lnRFLOOR	107009.3	77712.37	1.38	0.169	-45743.28	259761.9
lnLOTSIZE	2286862	166187.6	13.76	0.000	1960201	2613523
lnBATH	953373.1	204883.9	4.65	0.000	550650.2	1356096
lnCBD_DIST	-526358.3	238431.4	-2.21	0.028	-995022.7	-57693.93
lnBTS_DIST	-215715.4	48960.68	-4.41	0.000	-311953.3	-119477.6
lnMALL_DIST	7232.646	74223.95	0.10	0.922	-138663	153128.3
lnBEDROOM	9510.496	10033.22	0.95	0.344	-10210.96	29231.95
_cons	678218.5	1891760	0.36	0.720	-3040253	4396690

```
. . hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of PRICE

         chi2(1)      =   129.44
         Prob > chi2  =   0.0000


. . estat ic
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	441	-6946.886	-6627.588	20	13295.18	13376.96

Note: N=Obs used in calculating BIC; see [R] BIC note

```
. . reg PRICE POOL FITNESS GREEN_ENVI DUPPH NEWROOM FUR lnMAINROAD_DIST lnAGE lnHIGHT lnNOBUILD lnUNIT lnSQM_AREA lnRFLOOR lnLOTSIZE lnBATH ln
> CBD_DIST lnBTS_DIST lnMALL_DIST lnBEDROOM, robust

Linear regression                                      Number of obs =     441
                                                       F( 19,   421) =   78.85
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.7650
                                                       Root MSE      =  8.3e+05
```

PRICE	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
POOL	-580181	159928.6	-3.63	0.000	-894539	-265823
FITNESS	396953.1	257489.8	1.54	0.124	-109172.6	903078.8
GREEN_ENVI	260763.9	131192.9	1.99	0.047	2889.322	518638.6
DUPPH	1498594	553158.6	2.71	0.007	411297	2585891
NEWROOM	402315.9	126298.4	3.19	0.002	154061.9	650569.8
FUR	311057.9	104645.2	2.97	0.003	105365.8	516750
lnMAINROAD_DIST	-84290.06	25181.44	-3.35	0.001	-133787.1	-34793.05
lnAGE	-375519.1	77937.65	-4.82	0.000	-528714.5	-222323.7
lnHIGHT	796914	177716.3	4.48	0.000	447592.2	1146236
lnNOBUILD	413282	143727.5	2.88	0.004	130769.1	695794.9
lnUNIT	-731059.6	128494.6	-5.69	0.000	-983630.4	-478488.8
lnSQM_AREA	234780.3	92598.12	2.54	0.012	52768.1	416792.6
lnRFLOOR	107009.3	71341.94	1.50	0.134	-33221.48	247240.1
lnLOTSIZE	2286862	212888.4	10.74	0.000	1868405	2705318
lnBATH	953373.1	312213.2	3.05	0.002	339682.3	1567064
lnCBD_DIST	-526358.3	259600.6	-2.03	0.043	-1036633	-16083.47
lnBTS_DIST	-215715.4	49886.19	-4.32	0.000	-313772.5	-117658.4
lnMALL_DIST	7232.646	70184.17	0.10	0.918	-130722.4	145187.7
lnBEDROOM	9510.496	8540.46	1.11	0.266	-7276.758	26297.75
_cons	678218.5	1809913	0.37	0.708	-2879374	4235811

2. RBC Model

2.1 Box-Cox parameter

```
. . boxcox PRICE AGE  HIGHT NOBUILD UNIT SQM_AREA RFLOOR LOTSIZE  BATH MAINROAD_DIST   CBD_DIST BTS_DIST MALL_DIST , notrans ( BEDROOM POO
> TNESS  GREEN_ENVI  DUPPH NEWROOM FUR) model (lambda) lrtest nolog nologlr
Fitting comparison model

Fitting full model

Fitting comparison models for LR tests

                                                  Number of obs   =        441
                                                  LR chi2(19)     =     743.45
Log likelihood = -6510.8465                       Prob > chi2     =      0.000

------------------------------------------------------------------------------
       PRICE |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     /lambda |   .1324309   .0388145     3.41   0.001     .0563559    .2085059
------------------------------------------------------------------------------

Estimates of scale-variant parameters
----------------------------------------------------------
             |      Coef.  chi2(df)  P>chi2(df)  df of chi2
-------------+--------------------------------------------
Notrans      |
     BEDROOM |   .8090141   13.062    0.000          1
        POOL |  -1.676545   18.013    0.000          1
     FITNESS |    2.80329   33.060    0.000          1
  GREEN_ENVI |   1.115345   16.279    0.000          1
       DUPPH |   1.071947    2.333    0.127          1
     NEWROOM |   .4479435    2.795    0.095          1
         FUR |   .8603309   14.702    0.000          1
       _cons |    35.5137
-------------+--------------------------------------------
Trans        |
         AGE |  -.8221011   37.014   0.000           1
       HIGHT |   1.384713   29.890   0.000           1
     NOBUILD |   .8290589   10.115   0.001           1
        UNIT |  -.8144337   53.085   0.000           1
    SQM_AREA |   .1165755    5.716   0.017           1
      RFLOOR |   .1642531    1.565   0.211           1
     LOTSIZE |   3.215637  132.064   0.000           1
        BATH |    .215233    0.269   0.604           1
MAINROAD_D~T |  -.1417886   15.326   0.000           1
    CBD_DIST |  -.1312951    0.668   0.414           1
    BTS_DIST |   -.234815   21.315   0.000           1
   MALL_DIST |  -.1327389    4.159   0.041           1
-------------+--------------------------------------------
      /sigma |   1.743333
----------------------------------------------------------

---------------------------------------------------------
   Test         Restricted      LR statistic      P-value
   H0:        log likelihood        chi2        Prob > chi2
---------------------------------------------------------
```

2.2 RBC Result

```
. . reg PRICErbc POOL FITNESS GREEN_ENVI DUPPH NEWROOM FUR AGE HIGHT NOBUILD UNIT SQM_AREA RFLOOR LOTSIZE BEDROOM BATH CBD_DIST BTS_DIST MALL_
> DIST MAINROAD_DIST
```

Source	SS	df	MS
Model	5935.83765	19	312.412508
Residual	1340.37283	421	3.18378345
Total	7276.21048	440	16.536842

```
Number of obs =     441
F( 19,   421) =   98.13
Prob > F      =  0.0000
R-squared     =  0.8158
Adj R-squared =  0.8075
Root MSE      =  1.7843
```

PRICErbc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
POOL	-1.676158	.3997829	-4.19	0.000	-2.461977	-.8903386
FITNESS	2.802948	.4793673	5.85	0.000	1.860696	3.745199
GREEN_ENVI	1.115849	.2782481	4.01	0.000	.5689203	1.662777
DUPPH	1.071716	.7063835	1.52	0.130	-.3167616	2.460194
NEWROOM	.4480564	.2704967	1.66	0.098	-.0836359	.9797488
FUR	.8603181	.2276644	3.78	0.000	.4128175	1.307819
AGE	-.8219836	.135419	-6.07	0.000	-1.088165	-.5558019
HIGHT	1.385005	.2546525	5.44	0.000	.8844558	1.885553
NOBUILD	.8289193	.2626827	3.16	0.002	.3125862	1.345252
UNIT	-.8145221	.1109334	-7.34	0.000	-1.032574	-.5964698
SQM_AREA	.1165501	.049617	2.35	0.019	.0190221	.214078
RFLOOR	.1641884	.1342464	1.22	0.222	-.0996884	.4280652
LOTSIZE	3.214874	.2641336	12.17	0.000	2.695689	3.734059
BEDROOM	.8092137	.2274013	3.56	0.000	.3622304	1.256197
BATH	.2158519	.4232646	0.51	0.610	-.6161233	1.047827
CBD_DIST	-.1311131	.1632005	-0.80	0.422	-.4519024	.1896763
BTS_DIST	-.2347787	.048048	-4.89	0.000	-.3292225	-.1403348
MALL_DIST	-.1326404	.0642933	-2.06	0.040	-.2590163	-.0062644
MAINROAD_DIST	-.1417854	.0360585	-3.93	0.000	-.2126626	-.0709082
_cons	35.51236	2.650122	13.40	0.000	30.30325	40.72148

```
. . hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of PRICErbc

         chi2(1)      =     2.10
         Prob > chi2  =   0.1470

. . estat ic
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	441	-1243.884	-870.8725	20	1781.745	1863.526

Note: N=Obs used in calculating BIC; see [R] BIC note

.

3. UBC Model

3.1 Box-Cox parameter

```
. . boxcox PRICE AGE  HIGHT NOBUILD UNIT SQM_AREA RFLOOR LOTSIZE  BATH MAINROAD_DIST   CBD_DIST BTS_DIST MALL_DIST , notrans ( BEDROOM POOl
> TNESS  GREEN_ENVI  DUPPH NEWROOM FUR) model (theta) lrtest nolog nologlr
Fitting comparison model

Fitting full model

Fitting comparison models for LR tests

                                                  Number of obs   =        441
                                                  LR chi2(20)     =     751.98
Log likelihood = -6506.58                         Prob > chi2     =      0.000

------------------------------------------------------------------------------
       PRICE |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     /lambda |  -.0721928    .085621    -0.84   0.399    -.2400069    .0956212
      /theta |   .1959884   .0463975     4.22   0.000      .105051    .2869258
------------------------------------------------------------------------------

Estimates of scale-variant parameters
----------------------------------------------------------
             |      Coef.   chi2(df)  P>chi2(df)  df of chi2
-------------+--------------------------------------------
Notrans      |
     BEDROOM |   1.748337      9.362    0.002          1
        POOL |  -4.069915     16.706    0.000          1
     FITNESS |   6.884389     30.404    0.000          1
  GREEN_ENVI |   2.887216     16.630    0.000          1
       DUPPH |   3.029174      2.941    0.086          1
     NEWROOM |     1.2069      3.154    0.076          1
         FUR |   2.013725     12.464    0.000          1
       _cons |   65.24208
-------------+--------------------------------------------
Trans        |
         AGE |  -2.666605     32.847    0.000          1
       HIGHT |   6.053927     30.962    0.000          1
     NOBUILD |   1.980022      7.031    0.008          1
        UNIT |  -6.671743     56.146    0.000          1
    SQM_AREA |   2.086302      8.058    0.005          1
      RFLOOR |   .6378324      1.920    0.166          1
     LOTSIZE |   18.51141    140.136    0.000          1
        BATH |   1.578613      1.790    0.181          1
MAINROAD_D~T |  -.4381184     11.024    0.001          1
    CBD_DIST |  -2.596351      1.198    0.274          1
    BTS_DIST |  -2.788709     29.679    0.000          1
   MALL_DIST |  -1.562845      5.740    0.017          1
-------------+--------------------------------------------
      /sigma |   4.406333
----------------------------------------------------------

---------------------------------------------------------
   Test          Restricted
    H0:        log likelihood     chi2      Prob > chi2
---------------------------------------------------------
```

3.2 UBC Result

```
. . reg PRICEubc POOL FITNESS GREEN_ENVI DUPPH NEWROOM FUR AGE HIGHT NOBUILD UNIT SQM_AREA RFLOOR LOTSIZE BATH BEDROOM CBD_DIST BTS_DIST MALL_
> DIST MAINROAD_DIST
```

Source	SS	df	MS
Model	38588.8948	19	2030.99446
Residual	8563.49437	421	20.3408417
Total	47152.3892	440	107.164521

Number of obs =	441
F(19, 421) =	99.85
Prob > F =	0.0000
R-squared =	0.8184
Adj R-squared =	0.8102
Root MSE =	4.5101

PRICEubc	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
POOL	-4.069158	1.007427	-4.04	0.000	-6.049371	-2.088944
FITNESS	6.881229	1.195608	5.76	0.000	4.531125	9.231333
GREEN_ENVI	2.889914	.7096131	4.07	0.000	1.495088	4.28474
DUPPH	3.0283	1.768921	1.71	0.088	-.4487164	6.505317
NEWROOM	1.207714	.6882254	1.75	0.080	-.1450716	2.5605
FUR	2.014689	.575559	3.50	0.001	.8833616	3.146016
AGE	-2.665493	.452024	-5.90	0.000	-3.553998	-1.776988
HIGHT	6.049077	1.081983	5.59	0.000	3.922316	8.175838
NOBUILD	1.97823	.73526	2.69	0.007	.5329916	3.423468
UNIT	-6.671937	.8803018	-7.58	0.000	-8.402271	-4.941603
SQM_AREA	2.090704	.7473691	2.80	0.005	.6216639	3.559744
RFLOOR	.6400628	.470047	1.36	0.174	-.2838685	1.563994
LOTSIZE	18.50248	1.452471	12.74	0.000	15.64748	21.35748
BATH	1.582299	1.149504	1.38	0.169	-.6771833	3.841781
BEDROOM	1.748897	.5751574	3.04	0.003	.618359	2.879435
CBD_DIST	-2.601837	2.392878	-1.09	0.278	-7.305314	2.10164
BTS_DIST	-2.787523	.4006201	-6.96	0.000	-3.574988	-2.000058
MALL_DIST	-1.561898	.6513287	-2.40	0.017	-2.842159	-.2816362
MAINROAD_DIST	-.4378797	.1312101	-3.34	0.001	-.6957882	-.1799711
_cons	65.27256	13.81602	4.72	0.000	38.11559	92.42953

```
. . hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of PRICEubc

         chi2(1)      =     0.05
         Prob > chi2  =   0.8171

. . estat ic
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	441	-1655.949	-1279.803	20	2599.606	2681.387

Note: N=Obs used in calculating BIC; see [R] BIC note

APPENDIX B

ESTIMATED BETTERMENT TAX BY CONDOMINIUMS

Estimated Betterment Tax by Condominiums

Estimated Betterment Tax for Condominiums Locate with in 1,000 meter from the BTS station: Light Green Lines Extension (On-Nut to Baering)

Table A.1 Estimated Betterment Tax for Condominiums Locate with in 1,000 meter from the BTS Station

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
1	79	326.75	54,566.21	4,310,730.74	6,690.73	528,567.74	4,870.07	384,735.65
2	45	750.64	20,210.02	909,450.97	2,478.09	111,513.91	1,803.76	81,169.12
3	96	969.19	2,497.26	239,736.92	306.21	29,395.76	222.88	21,396.68
4	66	929.45	5,718.37	377,412.15	701.17	46,277.05	510.37	33,684.29
5	79	54.92	76,597.90	6,051,233.82	9,392.18	741,982.54	6,836.41	540,076.73
6	105	558.88	35,752.06	3,753,966.14	4,383.80	460,299.08	3,190.90	335,044.03
7	143	316.67	55,383.24	7,919,803.86	6,790.91	971,100.50	4,942.99	706,847.88
8	350	895.15	8,497.74	2,974,209.41	1,041.97	364,687.85	758.43	265,450.21
9	127	888.54	9,033.42	1,147,244.10	1,107.65	140,671.33	806.24	102,392.32
10	368	762.90	19,216.68	7,071,737.83	2,356.29	867,113.42	1,715.10	631,157.41
11	77	504.35	40,171.82	3,093,230.29	4,925.74	379,281.80	3,585.36	276,072.91
12	154	576.65	34,311.78	5,284,014.73	4,207.20	647,908.64	3,062.35	471,601.91

Table A.1 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
13	199	530.82	38,026.75	7,567,324.17	4,662.72	927,880.60	3,393.91	675,388.83
14	198	530.05	38,088.50	7,541,523.81	4,670.29	924,717.04	3,399.42	673,086.13
15	879	467.12	43,189.14	37,963,251.57	5,295.71	4,654,930.02	3,854.66	3,388,246.01
16	171	796.78	16,471.08	2,816,554.19	2,019.63	345,356.68	1,470.05	251,379.38
17	210	467.12	43,189.14	9,069,718.81	5,295.71	1,112,099.32	3,854.66	809,478.57
18	164	472.69	42,738.14	7,009,054.46	5,240.41	859,427.38	3,814.41	625,562.88
19	487	161.05	67,995.45	33,113,784.63	8,337.38	4,060,304.21	6,068.64	2,955,427.79
20	122	469.19	43,021.41	5,248,612.19	5,275.15	643,567.70	3,839.69	468,442.21
21	129	451.20	44,479.80	5,737,894.04	5,453.97	703,561.84	3,969.85	512,110.94
22	56	271.29	59,061.07	3,307,420.02	7,241.88	405,545.05	5,271.24	295,189.49
23	77	530.18	38,078.54	2,932,047.31	4,669.07	359,518.07	3,398.54	261,687.22
24	63	530.18	38,078.54	2,398,947.80	4,669.07	294,151.15	3,398.54	214,107.72
25	1,172	159.55	68,117.58	79,833,801.87	8,352.36	9,788,960.26	6,079.54	7,125,221.09
26	332	467.12	43,189.14	14,338,793.54	5,295.71	1,758,176.07	3,854.66	1,279,747.07
27	218	343.52	53,207.11	11,599,150.15	6,524.08	1,422,249.94	4,748.77	1,035,232.04
28	262	73.45	75,095.29	19,674,967.14	9,207.94	2,412,480.26	6,702.31	1,756,004.19
29	192	300.16	56,721.39	10,890,506.20	6,954.99	1,335,358.33	5,062.42	971,985.08
30	149	358.34	52,005.96	7,748,888.50	6,376.80	950,143.42	4,641.57	691,593.57
31	234	403.94	48,309.68	11,304,466.22	5,923.58	1,386,116.76	4,311.67	1,008,931.30
32	376	177.52	66,661.06	25,064,559.99	8,173.76	3,073,334.55	5,949.55	2,237,029.02

Table A.1 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
33	583	180.28	66,437.08	38,732,815.34	8,146.30	4,749,291.42	5,929.55	3,456,930.10
34	226	719.13	22,764.33	5,144,738.32	2,791.29	630,831.02	2,031.73	459,171.39
35	226	789.25	17,081.05	3,860,317.11	2,094.42	473,339.49	1,524.50	344,535.93
36	226	746.71	20,528.81	4,639,510.40	2,517.18	568,881.62	1,832.21	414,079.46
37	349	686.32	25,423.01	8,872,630.95	3,117.29	1,087,933.05	2,269.02	791,888.34
38	423	153.71	68,590.78	29,013,900.79	8,410.38	3,557,589.83	6,121.77	2,589,510.37
39	413	383.63	49,955.75	20,631,726.26	6,125.41	2,529,794.95	4,458.58	1,841,395.60
40	779	833.00	13,535.13	10,543,869.00	1,659.63	1,292,854.81	1,208.02	941,047.48
41	146	223.00	62,974.84	9,194,327.03	7,721.77	1,127,378.38	5,620.55	820,599.94
42	810	692.30	24,938.69	20,200,335.74	3,057.90	2,476,899.25	2,225.79	1,802,893.70
43	218	223.00	62,974.84	13,728,515.71	7,721.77	1,683,345.80	5,620.55	1,225,279.36
44	940	250.84	60,718.45	57,075,339.97	7,445.10	6,998,391.93	5,419.16	5,094,012.90
45	460	805.85	15,735.64	7,238,392.81	1,929.45	887,548.10	1,404.42	646,031.48
46	79	266.17	59,475.97	4,698,601.64	7,292.75	576,127.20	5,308.27	419,353.39
47	56	306.03	56,245.21	3,149,731.80	6,896.60	386,209.83	5,019.92	281,115.70
48	56	271.29	59,061.07	3,307,420.02	7,241.88	405,545.05	5,271.24	295,189.49
49	74	270.00	59,165.55	4,378,250.97	7,254.69	536,846.85	5,280.57	390,761.88
min	***45***	***54.92***	***2,497.26***	***239,736.92***	***306.21***	***29,395.76***	***222.88***	***21,396.68***
max	***1,172***	***969.19***	***76,597.90***	***79,833,801.87***	***9,392.18***	***9,788,960.26***	***6,836.41***	***7,125,221.09***
average	***274***	***475.43***	***42,516.07***	***12,096,009.42***	***5,213.18***	***1,483,173.20***	***3,794.59***	***1,079,577.06***

Estimated Betterment Tax for Condominiums Locate with in 1,500 meter from the BTS station: Light Green Lines Extension (On-Nut to Baering)

Table A.2 Estimated Betterment Tax for Condominiums Locate with in 1,500 meter from the BTS Station

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
1	79	326.75	33,223.94	2,624,691.47	4,073.81	321,831.10	2,965.26	234,255.50
2	45	750.64	21,220.14	954,906.42	2,601.94	117,087.51	1,893.91	85,226.05
3	250	1,290.47	5,933.50	1,483,376.24	727.55	181,886.75	529.57	132,392.34
4	96	969.19	15,031.43	1,443,017.68	1,843.11	176,938.12	1,341.57	128,790.31
5	72	1,133.25	10,385.65	747,767.16	1,273.46	91,688.77	926.93	66,738.73
6	66	929.45	16,156.86	1,066,353.09	1,981.10	130,752.74	1,442.01	95,172.74
7	90	1,365.17	3,818.17	343,635.43	468.17	42,135.46	340.77	30,669.70
8	79	54.92	40,921.65	3,232,810.42	5,017.68	396,396.66	3,652.29	288,530.53
9	105	558.88	26,650.42	2,798,293.67	3,267.79	343,117.64	2,378.57	249,749.61
10	143	316.67	33,509.41	4,791,845.27	4,108.81	587,560.43	2,990.74	427,675.45
11	350	895.15	17,127.96	5,994,785.38	2,100.17	735,061.02	1,528.68	535,038.67
12	127	888.54	17,315.12	2,199,020.21	2,123.12	269,636.68	1,545.39	196,264.05
13	368	762.90	20,873.08	7,681,292.01	2,559.39	941,854.96	1,862.94	685,560.53
14	77	504.35	28,194.65	2,170,987.95	3,457.14	266,199.46	2,516.39	193,762.15
15	135	1,077.67	11,959.60	1,614,546.05	1,466.45	197,970.37	1,067.40	144,099.33

Table A.2 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
16	161	1,072.11	12,116.98	1,950,833.17	1,485.74	239,204.80	1,081.45	174,113.19
17	154	576.65	26,147.19	4,026,667.97	3,206.08	493,736.89	2,333.65	359,382.85
18	199	530.82	27,445.18	5,461,590.43	3,365.24	669,682.40	2,449.50	487,450.66
19	198	530.05	27,466.75	5,438,417.06	3,367.88	666,840.95	2,451.43	485,382.42
20	879	467.12	29,248.88	25,709,762.41	3,586.40	3,152,447.17	2,610.48	2,294,613.77
21	30	1,479.36	584.38	17,531.26	71.65	2,149.63	52.16	1,564.68
22	171	796.78	19,913.78	3,405,256.91	2,441.76	417,541.49	1,777.32	303,921.49
23	210	467.12	29,248.88	6,142,264.06	3,586.40	753,144.37	2,610.48	548,201.24
24	164	472.69	29,091.30	4,770,973.25	3,567.08	585,001.17	2,596.42	425,812.61
25	487	161.05	37,916.02	18,465,101.65	4,649.14	2,264,130.51	3,384.03	1,648,022.88
26	122	469.19	29,190.27	3,561,213.47	3,579.22	436,664.37	2,605.25	317,840.72
27	129	451.20	29,699.82	3,831,277.31	3,641.70	469,778.72	2,650.73	341,944.10
28	56	271.29	34,794.41	1,948,487.16	4,266.38	238,917.14	3,105.43	173,903.80
29	77	530.18	27,463.27	2,114,671.81	3,367.46	259,294.16	2,451.12	188,735.90
30	63	530.18	27,463.27	1,730,186.02	3,367.46	212,149.76	2,451.12	154,420.28
31	1,172	159.55	37,958.69	44,487,584.94	4,654.37	5,454,922.49	3,387.84	3,970,547.20
32	332	467.12	29,248.88	9,710,626.99	3,586.40	1,190,685.39	2,610.48	866,680.06
33	218	343.52	32,749.08	7,139,300.02	4,015.59	875,397.67	2,922.88	637,187.38
34	107	1,085.47	11,738.68	1,256,038.62	1,439.36	154,011.36	1,047.69	112,102.30

Table A.2 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	**Tax burden per condominium**	**Tax burden per unit**	**Tax burden per condominium**	**Tax burden per unit**	**Tax burden per condominium**
35	138	1,085.47	11,738.68	1,619,937.66	1,439.36	198,631.47	1,047.69	144,580.54
36	262	73.45	40,396.65	10,583,923.04	4,953.31	1,297,766.10	3,605.43	944,622.33
37	192	300.16	33,976.94	6,523,573.38	4,166.14	799,899.28	3,032.47	582,233.36
38	149	358.34	32,329.41	4,817,082.17	3,964.13	590,654.90	2,885.42	429,927.86
39	234	403.94	31,037.96	7,262,882.18	3,805.77	890,550.91	2,770.16	648,217.17
40	376	177.52	37,449.79	14,081,122.83	4,591.97	1,726,581.33	3,342.42	1,256,749.79
41	583	180.28	37,371.54	21,787,604.95	4,582.38	2,671,525.02	3,335.43	1,944,558.55
42	226	719.13	22,112.60	4,997,447.34	2,711.37	612,770.69	1,973.56	446,025.57
43	226	789.25	20,126.90	4,548,680.03	2,467.90	557,744.30	1,796.34	405,972.79
44	226	746.71	21,331.52	4,820,924.43	2,615.60	591,126.02	1,903.85	430,270.78
45	349	686.32	23,041.52	8,041,491.51	2,825.28	986,021.45	2,056.47	717,708.58
46	423	153.71	38,124.02	16,126,462.18	4,674.64	1,977,374.17	3,402.60	1,439,297.71
47	413	383.63	31,613.08	13,056,203.04	3,876.29	1,600,909.01	2,821.49	1,165,275.00
48	779	833.00	18,887.99	14,713,741.09	2,315.98	1,804,150.92	1,685.77	1,313,211.40
49	146	223.00	36,161.86	5,279,631.01	4,434.05	647,371.13	3,227.47	471,210.66
50	810	692.30	22,872.30	18,526,565.66	2,804.53	2,271,667.02	2,041.37	1,653,508.58
51	218	223.00	36,161.86	7,883,284.66	4,434.05	966,622.64	3,227.47	703,588.52
52	940	250.84	35,373.49	33,251,078.84	4,337.38	4,077,138.78	3,157.11	2,967,681.39
53	460	805.85	19,656.83	9,042,139.75	2,410.26	1,108,717.67	1,754.39	807,017.12

Table A.2 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
54	79	266.17	34,939.38	2,760,210.70	4,284.15	338,448.03	3,118.36	246,350.68
55	56	306.03	33,810.57	1,893,392.06	4,145.74	232,161.56	3,017.62	168,986.53
56	56	271.29	34,794.41	1,948,487.16	4,266.38	238,917.14	3,105.43	173,903.80
57	138	1,044.41	12,901.32	1,780,381.56	1,581.92	218,304.58	1,151.45	158,900.26
58	74	270.00	34,830.92	2,577,487.98	4,270.85	316,043.17	3,108.68	230,042.55
59	60	1,100.00	11,327.13	679,627.68	1,388.90	83,333.73	1,010.95	60,657.23
min	***30***	***54.92***	***584.38***	***17,531.26***	***71.65***	***2,149.63***	***52.16***	***1,564.68***
max	***1,172***	***1,479.36***	***40,921.65***	***44,487,584.94***	***5,017.68***	***5,454,922.49***	***3,652.29***	***3,970,547.20***
average	***248***	***593.72***	***25,664.00***	***6,930,821.62***	***3,146.84***	***849,834.73***	***2,290.53***	***618,580.54***

Estimated Betterment Tax for Condominiums Locate with in 2,000 meter from the BTS station: Light Green Lines Extension (On-Nut to Baering)

Table A.3 Estimated Betterment Tax for Condominiums Locate with in 2,000 meter from the BTS Station

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
1	198	1,757.52	3,409.09	674,998.93	418.01	82,766.17	304.26	60,244.11
2	79	326.75	23,524.94	1,858,470.34	2,884.55	227,879.57	2,099.62	165,869.74
3	45	750.64	17,565.22	790,434.80	2,153.79	96,920.54	1,567.71	70,546.84
4	250	1,290.47	9,975.61	2,493,902.60	1,223.18	305,794.20	890.33	222,582.50
5	96	969.19	14,492.61	1,391,290.40	1,777.04	170,595.49	1,293.48	124,173.61
6	72	1,133.25	12,186.04	877,395.04	1,494.21	107,583.32	1,087.61	78,308.10
7	205	1,757.52	3,409.09	698,862.53	418.01	85,692.24	304.26	62,373.96
8	66	929.45	15,051.37	993,390.38	1,845.55	121,806.29	1,343.34	88,660.77
9	90	1,365.17	8,925.38	803,283.85	1,094.40	98,496.04	796.60	71,693.63
10	79	54.92	27,346.75	2,160,393.12	3,353.17	264,900.35	2,440.72	192,816.55
11	78	1,707.08	4,118.29	321,226.99	504.97	39,387.81	367.56	28,669.73
12	45	1,843.57	2,199.26	98,966.64	269.67	12,134.97	196.29	8,832.84
13	105	558.88	20,261.27	2,127,433.83	2,484.37	260,858.99	1,808.33	189,874.92
14	143	316.67	23,666.67	3,384,333.87	2,901.93	414,975.98	2,112.27	302,054.10
15	162	1,543.38	6,419.75	1,040,000.07	787.17	127,521.41	572.97	92,820.71

Table A.3 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
16	350	895.15	15,533.50	5,436,726.39	1,904.67	666,633.65	1,386.38	485,231.53
17	127	888.54	15,626.43	1,984,556.25	1,916.06	243,339.81	1,394.67	177,122.99
18	368	762.90	17,392.90	6,400,588.67	2,132.66	784,819.30	1,552.33	571,256.89
19	100	1,643.59	5,010.97	501,097.50	614.43	61,442.94	447.23	44,723.29
20	77	504.35	21,027.97	1,619,153.31	2,578.38	198,535.30	1,876.76	144,510.53
21	135	1,077.67	12,967.48	1,750,610.43	1,590.03	214,654.14	1,157.36	156,243.17
22	161	1,072.11	13,045.62	2,100,344.77	1,599.61	257,537.42	1,164.33	187,457.20
23	154	576.65	20,011.43	3,081,760.53	2,453.74	377,875.42	1,786.03	275,049.22
24	199	530.82	20,655.86	4,110,516.76	2,532.75	504,018.15	1,843.55	366,866.42
25	198	530.05	20,666.57	4,091,981.79	2,534.07	501,745.45	1,844.51	365,212.16
26	879	467.12	21,551.37	18,943,658.46	2,642.56	2,322,809.58	1,923.47	1,690,734.40
27	163	1,517.18	6,788.10	1,106,460.24	832.33	135,670.54	605.84	98,752.33
28	30	1,479.36	7,319.84	219,595.21	897.53	26,926.05	653.30	19,599.02
29	171	796.78	16,916.63	2,892,743.40	2,074.26	354,698.76	1,509.82	258,179.32
30	210	467.12	21,551.37	4,525,788.71	2,642.56	554,937.44	1,923.47	403,929.72
31	164	472.69	21,473.14	3,521,595.02	2,632.97	431,806.49	1,916.49	314,304.75
32	487	161.05	25,854.49	12,591,138.30	3,170.19	1,543,884.29	2,307.53	1,123,767.65
33	122	469.19	21,522.28	2,625,718.12	2,638.99	321,956.99	1,920.88	234,347.13
34	129	451.20	21,775.26	2,809,009.08	2,670.01	344,431.53	1,943.46	250,705.97

Table A.3 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium	Tax burden per unit	Tax burden per condominium
35	56	271.29	24,304.66	1,361,060.87	2,980.16	166,888.84	2,169.21	121,475.61
36	77	530.18	20,664.85	1,591,193.11	2,533.86	195,106.91	1,844.35	142,015.07
37	63	530.18	20,664.85	1,301,885.27	2,533.86	159,632.92	1,844.35	116,194.15
38	1,172	159.55	25,875.68	30,326,295.45	3,172.79	3,718,511.38	2,309.42	2,706,642.49
39	332	467.12	21,551.37	7,155,056.44	2,642.56	877,329.67	1,923.47	638,593.65
40	218	343.52	23,289.18	5,077,041.13	2,855.64	622,530.22	2,078.58	453,129.37
41	107	1,085.47	12,857.80	1,375,784.61	1,576.58	168,694.22	1,147.57	122,789.71
42	138	1,085.47	12,857.80	1,774,376.41	1,576.58	217,568.25	1,147.57	158,364.30
43	270	1,636.97	5,104.05	1,378,094.81	625.84	168,977.49	455.54	122,995.90
44	262	73.45	27,086.09	7,096,556.61	3,321.21	870,156.61	2,417.45	633,372.50
45	192	300.16	23,898.80	4,588,568.89	2,930.39	562,635.34	2,132.98	409,532.89
46	149	358.34	23,080.82	3,439,041.88	2,830.09	421,684.09	2,059.98	306,936.83
47	234	403.94	22,439.63	5,250,873.29	2,751.47	643,844.95	2,002.75	468,644.01
48	376	177.52	25,623.02	9,634,255.16	3,141.81	1,181,320.93	2,286.87	859,863.82
49	583	180.28	25,584.16	14,915,567.72	3,137.05	1,828,898.24	2,283.40	1,331,224.56
50	226	719.13	18,008.31	4,069,878.10	2,208.12	499,035.17	1,607.25	363,239.39
51	226	789.25	17,022.44	3,847,071.24	2,087.24	471,715.32	1,519.26	343,353.72
52	226	746.71	17,620.52	3,982,236.88	2,160.57	488,288.89	1,572.64	355,417.35
53	349	686.32	18,469.51	6,445,858.41	2,264.67	790,370.12	1,648.42	575,297.25

Table A.3 (Continued)

No.	UNIT	Distance to BTS station (m)	One-time charge (baht)		Annual charge (10 years) (baht)		Annual charge (15 years) (baht)	
			Tax burden per unit	**Tax burden per condominium**	**Tax burden per unit**	**Tax burden per condominium**	**Tax burden per unit**	**Tax burden per condominium**
54	423	153.71	25,957.76	10,980,134.48	3,182.86	1,346,348.26	2,316.75	979,984.47
55	413	383.63	22,725.17	9,385,495.57	2,786.49	1,150,818.84	2,028.24	837,661.86
56	779	833.00	16,407.33	12,781,313.03	2,011.81	1,567,202.89	1,464.37	1,140,740.88
57	146	223.00	24,983.58	3,647,601.97	3,063.40	447,257.05	2,229.80	325,550.96
58	336	1,700.00	4,217.82	1,417,188.73	517.18	173,771.06	376.44	126,485.06
59	810	692.30	18,385.49	14,892,249.39	2,254.37	1,826,039.02	1,640.92	1,329,143.38
60	218	223.00	24,983.58	5,446,419.38	3,063.40	667,822.17	2,229.80	486,096.63
61	940	250.84	24,592.16	23,116,631.42	3,015.41	2,834,485.91	2,194.87	2,063,175.07
62	460	805.85	16,789.05	7,722,964.00	2,058.62	946,964.64	1,498.43	689,279.79
63	79	266.17	24,376.63	1,925,753.79	2,988.98	236,129.65	2,175.63	171,874.84
64	56	306.03	23,816.19	1,333,706.90	2,920.26	163,534.79	2,125.61	119,034.25
65	56	271.29	24,304.66	1,361,060.87	2,980.16	166,888.84	2,169.21	121,475.61
66	138	1,044.41	13,435.03	1,854,034.62	1,647.36	227,335.68	1,199.09	165,473.85
67	270	1,636.97	5,104.05	1,378,094.81	625.84	168,977.49	455.54	122,995.90
68	74	270.00	24,322.78	1,799,885.92	2,982.38	220,696.14	2,170.82	160,641.04
69	60	1,100.00	12,653.47	759,208.25	1,551.53	93,091.64	1,129.33	67,759.85
Min	***30***	***54.92***	***2,199.26***	***98,966.64***	***269.67***	***12,134.97***	***196.29***	***8,832.84***
Max	***1,172***	***1,843.57***	***27,346.75***	***30,326,295.45***	***3,353.17***	***3,718,511.38***	***2,440.72***	***2,706,642.49***
Average	***238***	***750.33***	***17,569.58***	***4,557,099.50***	***2,154.32***	***558,776.67***	***1,568.10***	***406,724.23***

BIOGRAPHY

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