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Master's Thesis

社會住宅對周邊住宅不動產價格之影響：以新北市為例

The Impact of Social Housing on Surrounding Residential Housing Price: New Taipei City Case

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Abstract

In recent years, the government has tried to solve the problem of high housing prices by developing social housing. However, nearby residents often think that social housing will cause low quality and falling housing prices in the surrounding living environment, which can be explained as a NIMBY(not in my backyard) facility. At present, apart from Taipei City and New Taipei City, the number of social housing samples in other counties and cities is slightly insufficient. As a result, most of the research in Taiwan on the relationship between social housing and housing prices is based on Taipei City. Hence, this study will focus on social housing in New Taipei City and observe whether it will cause falling housing prices or not.

This study applies OLS model based on Hedonic price theory, and conducts empirical analysis on the transaction price of real estate from 2016 to 2018 to study the effect of rental social housing on the surrounding residential price within 500 meters. The empirical results show that social housing within 500 meters will cause the surrounding residential price to increase significantly by about 2.5%, breaking the impression of NIMBY facility in the past.

Key Words: Social Housing, Housing Prices, Hedonic Price Theory

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I.INTRODUCTION

A.Background and Purpose

In recent years, salary has not been easy to increase and personal disposable income has fallen. Worse still, housing prices in the metropolitan area have soared and inflation problems have been severe. It has become a heavy burden for people to buy a house. In addition to expecting the government to start with economic policies such as finance and tax reform to reduce rising housing prices, people also expect the government to build public housing and provide economically disadvantaged people to live in suitable houses at lower prices, so as to improve the living environment and improve quality of life and protect their right to live.

In order to respond to the people's housing needs and solve the problem of long-term residency rights, the Executive Yuan announced Article 3 of the Housing Law in 2011: "Social housing refers to housing and necessary facilities built by the government or by the private sector with subsidies from the government that is primarily rented., and at least 30% of social housing built by the competent authority and private sector calculated based on the jurisdiction of each municipal, county (city) government shall be rented to economically or socially disadvantaged persons." In 2011, the Executive Yuan also promoted the “Social Housing Short-Term Implementation Plan” and selected five pilot sites in Taipei City and New Taipei City. Then, in 2014, the “Medium and Medium-Term Promotion Plan for Social Housing” was approved. It is planned to build 15,100 social housing units by 2023. However, this policy immediately caused a rebound in the residents near the pilot base. Taiwanese are more obsessed with owning private properties and believe that owning a property can be settled and the property is considered a property of preservation. In addition, residents do not understand the significance of social housing and distrust of past government housing policies, leading to the stereotype that social housing will lower the quality of the community (張金鶚，2011). Therefore, when the government announced the trial of social housing, under the prejudice of residents, it is feared that social housing will bring about a large number of negative impacts in the residential community, and thus affect the quality of the living environment and the loss of its own property. 李子璋 (2013) pointed out that in

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2013, the Ministry of Finance planned to set up an elderly housing in Neihu, which was also strongly opposed by nearby residents.

At present, apart from Taipei City and New Taipei City, the number of social housing samples in other counties and cities is slightly insufficient, so it is difficult to infer the relationship between social housing and housing prices. Many scholars have been researching on the various factors that affect the price of the house. Factors affecting housing prices can be divided into three categories: building qualities, locational qualities, and neighborhood qualities. (Muhamad Hilmi b Mohamad, 2016) Conditions of a building are regarded one of the most important aspects of housing. Therefore, this is the first item and factor being input in the overall measurement in many studies. Factors in this categories include building area, land area, building age, building type, etc. Other than building qualities, locational qualities have also been valued by many scholars. Locational qualities include distance to city center, transportation system, hospital, etc. Heikkila et al. (1989), Richardson et al. (1990), and McMillen (2003) studied whether the distance to CBD (Central Business District) would affect housing price or not. Bajic,V. (1983), Gatzlaff and Smith (1993), McMillen and McDonald (2004) studied the impact of MRT system and railway on housing price. As for neighborhood qualities, NIMBY[1] facilities (e.g. homeless shelters, oil wells, chemical plants, industrial parks, military bases, wind turbines), park and school are the main factors that are studied. When social housing was developed, it was considered as a NIMBY facility as well. In 1963, Nourse first made a study on the relationship between public housing and surrounding housing prices. After that, some scholars gradually do research on the relationship between public housing and housing prices in different regions, such as Schaffr(1972), Guy Hyson Ruth (1985), Micheal and MaRous(1996), Nguyen(2005), and Freeman and Botein (2002). In Taiwan, 黃怡潔、江穎慧、張金鶚 (2017) studied the impact of four different types of social housing in Taipei City on the surrounding housing prices. In recent years, there have been empirical studies based on social housing in Taipei City. However, there is no empirical studies based on other city. Therefore, this study will focus on whether the social housing in New Taipei City will affect the surrounding housing prices since few people has explored this area. The purpose of this

[1] Not In My Backyard (NIMBY) is a characterization of opposition by residents to a proposed development in their local area. (Wikipedia, 2019)

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study is to observe the relationship between social housing and surrounding housing prices to clarify the correlation between social housing and its NIMBY effects. In addition, since the real estate price is composed of many characteristics. Therefore, in addition to discussing the impact of social housing on surrounding housing prices, this study will also explore the impact of other characteristics on housing prices in three aspects including building characteristic (e.g., area, floor, building age, building type), locational characteristic (e.g., distance to downtown, distance to MRT station) , and neighborhood characteristic (e.g., school).

B. Objectives and Scope

1. Research Objectives

The research object of this paper is to study the influence of social housing on the price of surrounding residential houses according to the "real estate transaction price inquiry service" of the Ministry of the Interior. At the same time, according to the various characteristics of the house, the impact of each characteristic attribute on house prices will be studied as well. This study will use the address location system and geographic information system software (QGIS) to measure the linear distance between real estate and social housing to explore the impact of social housing on housing transaction prices.

2. Spatial Scope

The spatial scope of this study is based on the social housing that has been leased in New Taipei City, and all the residential transactions in New Taipei City are collected for data research.

3. Time Scope

In 2011, the Executive Yuan promoted the "Social Housing Short-Term Implementation Plan" and selected five pilot sites in Taipei City and New Taipei City. In 2014, the "Social Housing Medium- and Long-Term Promotion Plan" was approved. The government of New Taipei City started construct the social housing. Since the construction

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of all the social housing used in this study are started before 2015, the time range of this study is from 2016 to 2018 based on real estate transaction data.

Table 1.1 Construction year of Social Housing in New Taipei City

Name	Construction Year
Linkou World Universiade Village Social Housing 林口世大運選手村社會住宅	2014
Sanchong House 1 三重 1 館	2013
Sanchong House 2 三重 2 館	2013
Sanchong House 3 三重 3 館	2013
Yonghe Youth Social Housing 永和青年住宅	2015
Yonghe Xiulang Police Station Youth Social Residence 永和秀朗派出所青年社會住宅	2015
Zhonghe Xiufeng Youth Social Housing 中和秀峰青年社會住宅	2013
Banqiao Fuzhong Youth Social Housing 板橋府中青年社會住宅	2015
Xinzhuang Xinfeng Youth Social Housing 新莊新豐青年社會住宅	2014
Sanxia Taipei University Youth Social Housing 三峽北大青年社會住宅	2013

Source: official website of the Social Housing of New Taipei City, 2019

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C.Research Method and Main Finding

In this study, the "Hedonic Price Model" would be used as research method to obtain the research results.

The Hedonic price model is a specific statistical regression model, assuming that the commodity consists of many different characteristics, and the commodity price is determined by the utility of all the characteristics to the user. Due to the different number and combination of characteristics, the price of the product is different. Therefore, through the regression analysis, the factors affecting the commodity price are decomposed, and the price implied by each influencing factor is obtained. This method is often applied to complex problems such as real estate research or land development and multiple complex considerations. Through the literature review and analysis, this study uses Hedonic price model to establish a mathematical model of the relationship between social housing and surrounding housing prices in New Taipei City, and analyzes and compares them according to the statistical results. According to the results, the residential housing price will increase when there is social housing within 500 meters, breaking the image of social housing as a NIMBY facility. The reason why social housing nowadays has no negative impact on house price is probably because that the target of social housing does not focus on economically disadvantaged people anymore but young people who just graduated from school and new to the society. Compared to economically disadvantaged groups, people usually don't have negative thoughts about young people. In addition, the government also focuses on better building design and better operational management, making social housing just like normal residential building.

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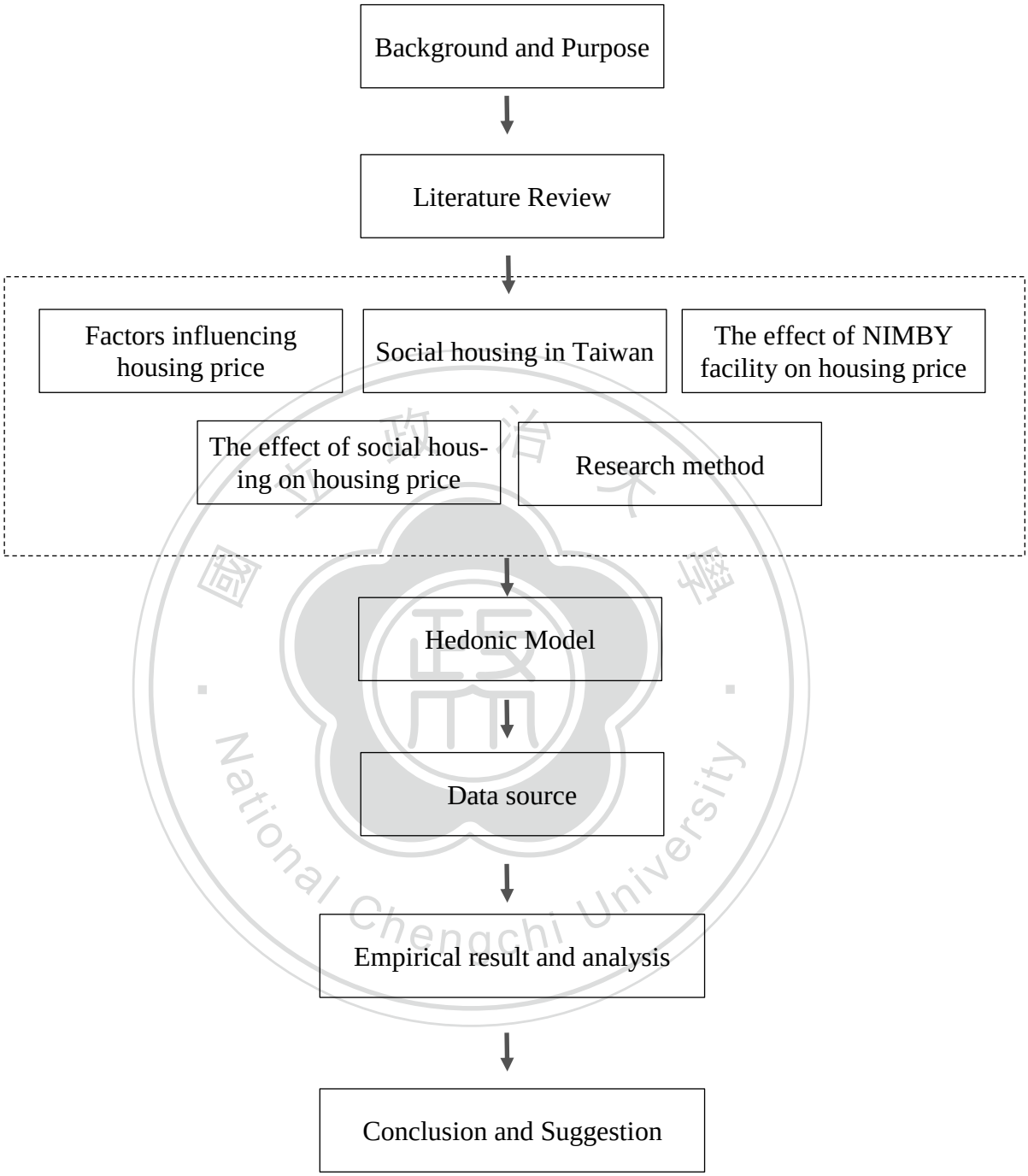
D.Framework



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II.LITERATURE REVIEW

A.Factors Influencing Housing Price

The factors affecting housing prices are very complex. Empirical studies have generally grouped determining variables into four subsets: (a) Structural or internal attributes describing the physical characteristics of housing. (b) Locational attributes including the distance to major places of employment, to major amenities, and to road infrastructure and transport access points. (c) Neighborhood attributes depicting the quality of the economic and social characteristics of the neighborhood.

Structural attributes describe the physical structure of property goods and land parcel. Compared with locational attributes, the structural attributes are easier to account for and accurately perceived. Sirmans et al. (2005) summarized the top twenty characteristics that have been used to specify hedonic pricing equations. Age shows up the most frequently in hedonic models and typically has the expected negative sign though it is seen to be positive or not significant in some studies. In historic cities, age may have a positive influence on price, but only in particular housing markets. Age in a modern part of a historic city may have a negative influence since the quality of modern era houses is typically inferior to those in historic quarters. Square footage is the next most used characteristics and typically has the expected positive effect in selling price. Other characteristics that appear frequently are garage, fireplace, and lot size. Each typically has the expected positive effect. Garage never has a negative sign, but it has been insignificant in a number of studies. Fireplace shows negative in only a few studies and lot size never shows up negative.

A property represents not only an amount of structural characteristics, but also a set of specific locational characteristics, which has long been regarded as the fundamental influence in the modeling of residential location. Von Thunen's classical land use model was the first to formally correlate value with systematic locational characteristics—distance to a central marketplace. Beckmann (1973) developed models of urban housing markets based on the central assumption that housing and employment accessibility were jointly purchased in the residential choice decision. Most early economic studies of housing price found there is a downward sloping housing price curve with

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distance from the central business district (CBD). Richardson et al. (1990) found a significantly negative value of the coefficient related to distance from the LA central business district in 1970, and this variable was found not to influence house prices in 1980. McMillen (2003) found that in many cities the central business district no longer appears to exert a significant influence on house value. Heikkila et al. (1989) suggested considering the possibility that accessibility to nodes other than the CBD (Central Business District) might be important. Bowes and Ihlanfeldt (2001) proposed that railway stations raise the value of nearby properties, as that reduce people's commuting costs, and station area should therefore be better able to attract retail activity. Gatzlaff and Smith (1993) used the Miami area subway station as the research target, using the total residential floor area, land area, residential sales year, total real estate price increase index, distance from Miami subway station to residential as the variables. The study pointed out that the announcement of the construction of the Miami Metro has a weak impact on real estate prices, and the construction of subway stations in the Miami area has caused the price of nearby real estate to rise slightly or even decline. McMillen and McDonald (2004) used the Chicago Midway Airport (Midway Airportru) MRT line as a research target, using residential properties (house age, base, area, room, storage room, building materials, basement, loft, central air conditioning, parking spaces) Neighboring environment (Spanish population, black population, vacant rate, 12 communities), traffic attributes (distance to nearby MRT station, distance to nearby station with stop, distance to nearby airport station, distance to downtown) . The results of the study indicate that the residential market has a clear expected effect on the MRT line. The expected benefits have begun to appear in the first six years of the MRT, and that each additional one mile from the station will cause the house price to fall by 19.4%.

Neighborhood attributes are also typically included in the estimation of housing price models. Important among these are income level. Generally, higher income neighborhoods are assumed to be of higher quality. This leads to the idea that all households prefer to live in higher income neighborhoods. Also, school quality is one of the most essential determinant of housing price. Gibbons and Machin (2003) investigated the impact of primary school performance on housing prices in England during the years from 1996 to 1999. They considered school type as the instrument for school quality and found a positive effect of local school quality on house price. Aside from factors mentioned above, public open space and parks could enhance the value of environment,

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as well as quality of life, by improving air quality and providing recreational opportunities, which leads to an increase of house price. (Nowak and McPherson 1993). In contrary, facilities that have a negative impact on the neighborhood such as substation, incineration plant, and funeral facilities, will have a negative impact on house prices. In Taiwan, 張金鶚 (2002) divided the attributes affecting real estate prices into characteristics of the household (floor, area, quality), characteristics of the building (location, building type, building age), characteristics of the neighborhood (NIMBY facilities, transportation, living convenience), macroeconomic characteristics, and other special characteristics.

B. Social Housing in Taiwan

According to Article 3 and 4 of the Housing Act: "Social housing refers to housing and necessary facilities built by the government or by the private sector with subsidies from the government that is primarily rented. Also, at least 30% of social housing built by the competent authority and private sector calculated based on the jurisdiction of each municipal, county (city) government shall be rented to economically or socially disadvantaged persons. A specific ratio of social housing shall be provided to persons whose permanent address is not registered in the area where they are going to school or working in." Economically or socially disadvantaged persons include low-income households, special circumstances families, seniors, physically and mentally handicapped and vulnerable families. Hence, social housing is a kind of residential welfare policy. It essentially defines social housing as the decommodificatios of residential housing. It is mainly targeted at the disadvantaged groups in society.(林萬億，2003) The main purpose of social housing is to provide housing, so that people who can't afford or rent in the residential market can have a suitable and affordable residential environment and quality of living. Social housing also involves many different residential terms, such as built-up houses, national houses, affordable houses, public houses, etc. These types of housing are all houses that the government directly or indirectly manages in response to different time and space.(黃怡潔、江穎慧、張金鶚，2017)

The earliest residential policy in Taiwan began in the development of the military dependents' villages. From 1951 to 1956, Taiwan was governed and ruled by another regime for the first time after 50 years of Japanese rule, and it was completed at the end

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of the second war. The housing welfare has been replaced by the change of the dynasty. The housing policy at this time is mainly aimed at the two major residential needs of the post-war military and post-disaster reconstruction. The concept of social housing has not taken shape. At this time, Taiwan is only a springboard for the Jiang family to counterattack China. Therefore, the housing construction in this period is biased towards temporary policies to meet the needs at that time.

In the late 1950s, Taiwan accepted the aid of the United States. Therefore, Taiwan's housing policy is deeply affected by the United States. People owning their own homes can stabilize the country's political and economic. However, at the time, Taiwan's agricultural and light industrial policies succeeded and the economy took off, resulting in rapid urbanization in Taipei. Population growth and residential supply were not equal. The urban population was digested by the private residential market, and the public housing policy was slowed down.

In 1975, the "Public Housing Act" was promulgated, which was a turning point in the development of public housing. The country changed from passive to institutionalized and directly involved in the construction of a large number of public housing for sale to the people. (陳怡伶、黎德星，2010) However, due to the poor location of some public houses, the inefficiency of government construction and the quality of contractors, some buildings are of poor quality and the people have a negative impression of public housing. (Chang and Yuan, 2013;米復國，1988) In the mid-1980s, the government turned part of the public houses into rental public houses. The cleaning management and equipment maintenance of the rental public houses is operated by the government by several management stations. However, due to insufficient management manpower and rigid maintenance management system, not only the residents have low satisfaction with the quality of the house, but also become a region with poor quality. (洪幸妙與張金鶚，1993;中華民國住宅學會，2008)

In 2011 and 2014, the government proposed the "Social Housing Short-term Implementation Plan" and the "Social Housing Medium- and Long-Term Promotion Plan - the First Phase Implementation Plan" to make more specific plans for the implementation of social housing policy. The plan mentioned the residents' reflection at the symposium. The social and economic disadvantages brought by social housing may make the place

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become a "slum", affecting the local public security and quality of life, and causing the surrounding house prices to fall. Therefore, it was considered that social housing should be based on mixed planning, improved operational management and social support systems as the main development goals.

C.The Effect of NIMBY on Surrounding Housing Prices

From the perspective of utility theory, all factors that contribute to the improvement of people's quality of life are important factors influencing housing prices. Some facilities can increase housing prices, such as cultural institutions or parks, and some disgusting facilities will cause resistance to rising prices. Those who feels disgusted by the people will lower the demand of the people and thus cause the house prices to fall. Therefore, under normal circumstances, if there are "disgusting facilities" around the home, it will naturally have a negative impact on housing prices. The “disgusting facilities” are normally called NIMBY (Not In MY Backyard) facilities. NIMBY is a characterization of opposition by residents to a proposed development in their local area. It often carries the connotation that such residents are only opposing the development because it is close to them, and that they would tolerate or support it if it were built farther away. NIMBY facilities can be generally divided into two categories: “those which is threatening life" and "those which is obstructing peace”.

In general, the so-called life-threatening NIMBY facilities refer to public facilities that may affect people's lives, such as airports, high-voltage electric towers, and large gas companies or giant gas troughs, gas stations, transformer box, etc. Because of the disasters caused by these large-scale public facilities, it may bring people's lives unsafely. Normally, people is unwilling to purchase this type of real estate. The price difference between them and the real estate in the same district but no NIMBY facilities around is usually more than 10%.

In terms of the NIMBY facilities that impede tranquility, the negative impact of such NIMBY facilities is mainly to affect the quality of the home. The most common example is the altar. The residents must endure the smoke, the noise generated by the the gods worshiping, and the potential fire risks. In addition, the buildings along the viaduct and the elevated MRT will be affected by road vibrations and noise caused by the car, and the privacy of the home will be reduced. In addition to the garbage mountain, there

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are about 20 kinds of NIMBY facilities such as incinerators, funeral homes, gas stations, and altars. NIMBY is a characterization of opposition by residents to a proposed development in their local area. It often carries the connotation that such residents are only opposing the development because it is close to them, and that they would tolerate or support it if it were built farther away.

In 1994, Galster studied the effect of special housing, especially mental health rehabilitation center, on surrounding housing price. The study described the nearby residents' long-term concern about the mental illness patients living in their neighborhood. And the patients with mental illness are considered to be unwanted groups. The study pointed out that living near SMD had no significant effect on house prices.

In 2009, Chernobai and Reibel wanted to know the impact of the new highway extension project on house prices. The study assumes that the added highway will have varying degrees of impact on users at different distances and that the impact is not linear. Residents close to the highway can enjoy the shortest route and time from commuting to the city center, but on the other hand must tolerate the negative effects of exhaust, noise and road congestion. The results of the study indicate that those with moderate distance from the highway enjoy the highest prices.

In 2011, 楊宗憲 and 蘇倖慧 studied the impact of YIMBY[2] facilities and NIMBY facilities on housing prices. The results show that schools, large parks, department stores, MRT stations and stadiums have a positive impact on housing prices. Conversely, funeral homes, sewage treatment plants, temples, substations and incineration plants, which have a physical and psychological impact on residents, have a negative impact on housing prices.

D.The Effect of Social Housing on Surrounding Housing Prices

Most of the research before the 1990s was to compare the price of two area, one with public housing and one without public housing. However, the research method has many limitations, such as the inability to fix other possible influencing factors, the neighborhood boundaries, the inability to simultaneously study different types of public

[2] YIMBY is an acronym for "Yes In My Back Yard," a pro-development movement in contrast and opposition to the NIMBY phenomenon. (Wikipedia, 2019)

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housing, and the limitation to small areas (Freeman and Botein, 2002; Nguyen, 2005). Freeman and Botein (2002) and Nguyen (2005) collected relevant literature and found that the related research after the 1990s mostly used Hedonic Price Method to analyze the relationship between social housing and housing price. Furthermore, because different types of public housing have different effects on the price of surrounding housing (Lee et al., 1999), Freeman and Botein (2002), Nguyen (2005) and Du Preez and Sale (2013) suggest that distinction should be made and compare the effects of different types of public housing on housing prices.

Taiwan's research on why social housing is considered as a NIMBY facility is mostly analyzed qualitatively. 沈孟穎 and 傅朝卿 (2015) believe that the quality of the early buildings and design was poor and the living area was too narrow. 師豫玲 (2008), 胡志平、林帝佑 (2013) and the Executive Yuan (2014) all believe that due to the lack of financial capacity of the residents to maintain, the houses are dilapidated, the public facilities are destroyed and the environmental quality is messy. In addition, the excessive concentration of the disadvantaged and the inability to lift poverty criminal labels is one of the reasons why social housing is considered to be a NIMBY facility. 黃怡潔、江穎慧、張金鶚(2017) conducted empirical analysis on real estate transaction data from July 2012 to September 2015, and studied the impact of four different types of social housing in Taipei City on the surrounding housing prices. The empirical results show that the housing prices where there are early built public housing and rental public housing are significantly low. The rise and fall of the total price of nearby residential houses where there are for-sale public housing is not significant. And the newly built public rental housing has caused a significant increase in the price of surrounding houses.

As for international studies, Nourse(1963) first made a study on the relationship between public housing and surrounding housing prices. In the research, Nourse's research motivation is to prove that the establishment of public housing will reduce slums and reduce crime, and that using new construction will gradually improve urban infrastructure to reduce disasters and improve sanitation. Therefore, Nourse assumes that the surrounding housing prices will rise. However, the study concludes that there is no substantial evidence in the three bases of the survey that can be speculated that the housing price has changed. In 1985, Guy Hyson Ruth conducted a counter-example at

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four bases in Virginia, and his research found that there is strong statistical evidence that the farther away from public housing, the higher the price of the surrounding houses. It's believed that public housing has a negative impact on surrounding housing price, but the conclusion will only apply to the four bases in Virginia. In 1996, Micheal and MaRous conducted research on whether low-cost housing affects the value of real estate around. In the study, the two put forward their opinions on this topic. It is generally believed that low-cost houses are made up of dirty and ugly houses with poor construction quality. Therefore, the terrible picture is deeply rooted in the hearts of ordinary people. It is conceivable that no one wants to become a neighbor with low-cost housing. The study wants to prove whether the negative label caused by low-cost housing is only a stereotype of people's imagination, and thus affect housing prices. The study conducted research on four extremely poor communities in the United States, and empirically pointed out that there is no clear evidence that low-cost housing affects surrounding housing prices. Galaster (1999) conducted a study on a low- and middle-income community in Baltimore, USA, and studied the price of the surrounding house price from 1991 to 1995. In Galaster's study, this low- and middle-income community has had a significant impact on the white-dominated high-quality residential community at 150 meters while there is no particular impact on normal houses within 600 meters. Freeman and Botein (2002) study the negative impacts of low-cost housing, including property impacts, ethnic issues, poverty gathering, and high crime rates. After theoretical and research methods, the results of the study show that they vary from region to region, partly positive and partly negative, and the conclusion appendix suggests that the study of poverty aggregation effects should be followed by more rigorous follow-up discussions.

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III.METHODOLOGY AND DATA

A.Hedonic Price Model

1. Introduction of Hedonic Price Model

The Hedonic price method is a regression model proposed by Rosen in 1974. The commodity is composed of many different characteristics, and the commodity price is determined by the utility of all the features to the user. Due to the different number and combination of features, the price of the product is different. Therefore, the price influence factor of the commodity is decomposed by regression analysis to find the price implied by each influencing factor.

Hedonic price model can be traced back to the 1939 Court study. In the study, Court used Hedonic price model in the automotive market. He disassembled the car's features, including seat size, window size, engine and other features, using mathematical regressions to list the implied prices corresponding to each feature. Since the 1960s, the concept of Hedonic price model has only begun to be widely used (Zvi Griliches, 1961). In 1974, Rosen combined the new consumer theory, utility theory and bid rent theory proposed by Lancaster in 1966 to develop this concept into a theoretical model that can be used as an empirical basis and become a widely used model. In 1989, Fischel first used the Hedonic price model to distinguish the supply side and the demand side of real estate market. This research method is widely welcomed by relevant urban planning policies. Hedonic price model assumes that when a purchaser purchases a property, it also represents the advantages of purchasing hidden goods around it, such as good neighbors, school districts, and good living environment (Boyle, Kiel, 2001). In the real estate market, because of the heterogeneity of real estate, it is generally difficult to quickly measure the price of a real property. The model defines a real estate consisting of multiple characteristics, all of which contribute to its value. Hedonic price model is used to estimate the marginal contribution of each characteristics.(Sirmans, Macpherson, Zietz, 2005). Hedonic price model provides a measure of the price of real estate.

Using Hedonic price model to measure the real estate price can be divided into two steps: First, establish a feature regression, the regression can be set to three types, including Linear, Log-Linear, Log-Log.(杜宇璇等，2013) Among them, the Log-Linear

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model is the most common.(吳秋霞，2007) Second, from the results of the regression, observe the change in the price of a property caused when a feature changes by one unit or percentage, holding other features unchanged.

2. Formula of Hedonic Price Model

This study will use semi-log regression model to conduct empirical analysis. The model is shown as below:

$$\ln(pricei) = \beta i0 + \sum \beta ikXik + \varepsilon \quad \text{……(1)}$$

pricei	:The *i*th transaction price
$\beta i0$	:The intercept
βik	:Coefficient of each characteristics
Xik	:The *k*th feature variable for the *i*th data
ε	:Error term

3. Research variable selection

In the study of house price in the theory of Hedonic price method, it is found that the house is a combination of different residential characteristics, and the different characteristics will vary according to the different consumer groups. Taking the swimming pool as an example, the swimming pool is more valuable for the tropics than the cold zone, so the difference in location and the difference in consumer preferences are also different, but in general some features have a certain degree of positive or negative impact. The following is a summary of the residential characteristics of the study area and is listed as a characteristic factor affecting house prices in the study.

3.1 The dependent variables

The dependent variables in this study is the logarithm of the residential total price of New Taipei City from 2016 to 2018. Logarithm of dependent variables can control the influence of extreme values, and can also be used to measure the degree of change

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without being affected by different units of variables, and has the ability to reduce heterogeneous variation. (Malpezzi, 2003)

3.2 The independent variables

The independent variables are shown in Table 3.1 as below.

Table 3.1 List of the independent variables

Items	Denotation
transaction area	area
transaction floor	flr
total floors	totalf
building age	age
distance to downtown	DisTP
building type	btype1, btype2
close to MRT station or not	mrt
close to excellent schools or not	schl
close to social housing or not	sochou

The model of this study is based on the various characteristic variables compiled in the previous chapter. The following is the structure of the empirical model of the study:

$$\ln(price) = \beta 0 + \beta 1\, area + \beta 2\, flr + \beta 3\, totalf + \beta 4\, age + \beta 5\, DisTP + \beta 6\, btype1 + \beta 7\, btype2 + \beta 8\, mrt + \beta 9\, schl + \beta 10\, sochou$$

This study will use semi-log regression model to conduct empirical analysis which can control the influence of extreme values, and can also be used to measure the degree of change without being affected by different units of variables, and has the ability to reduce heterogeneous variation. (Malpezzi, 2003)

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4. Expected Signs

Table 3.2 shows the summary of the variables. This part will describe each variable one by one.

(1)transaction area:

Transaction area is the floor area of the residential transaction sample. Cervero and Duncan(2004)、Ihlanfeldt(2007) proved that area positively affects house price. The larger the transaction area, the better the living environment. So, it is expected to have a positive effect on house prices.

(2)building type:

This variable is a dummy variable. The building in this study can be divided into 3 types: building under 5 floors without elevator, building under 10 floors with elevator, and building more than 10 floors with elevator. Since there are 3 types, 2 dummy variables should be set. The variable *btype1* is 0 and *btype2* is 0 when the building is under 5 floors without elevator; the variable *btype1* is 1 and *btype2* is 0 when the building is under 10 floors with elevator; and the variable *btype1* is 0 and *btype2* is 1 when the building is over 10 floors with elevator. Lin and Hwang (2003) studied the impact of MRT on house prices. Among them, the study divided the residential type into three categories: single-family houses, buildings and apartments. Studies have shown that the impact of the MRT system on residential prices has different degrees of impact due to different residential types. This study expect the house price of building over 5 floors is higher than building under 5 floors.

(3)transaction floor:

This variable is the transaction floor of the sample. Raymond (2002) studied Hong Kong's collective housing, and the results of the study show that high-floor units have higher residential prices because they have better views, ventilation and lighting. So, this study expected a positive relationship between transaction floor and house prices.

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(4)total floor:

This variable is the number of floors of the sample. The higher building, the higher construction costs. So it is expected to have a positive effect on house prices.

(5)building age:

Building age is the number of years of transaction sample from the completion date to the trading date. If the age of the house is larger, the building structure of the house itself will be relatively degraded due to depreciation. Glascock et al. (2000) and Bae et al. (2003) all pointed out that the higher the housing age, the lower the housing price, that is, the housing age has a negative impact on housing prices.

(6)distance to the downtown:

The results of Bowes and Ihlanfeldt (2001) show that retail business activities can increase the convenience of daily life and have a positive impact on housing prices, but too much commercial activity may also cause negative consequences for residential, resulting in decreases in house prices. So, this study anticipates a negative relationship between distance to downtown and house prices. Since New Taipei City is strongly connected to Taipei City and the commercial activities are concentrated in Taipei City, this study set Taipei Main Station as the city center to calculate the distance.

(7)whether it is close to social housing (within 500 meters):

This variable is a dummy variable and it will be 1 when there are social housing within 500 meters while it is 0 when there are no social housing within 500 meters. Social housing is considered as NIMBY facility due to the past image. So, this study anticipates a negative relationship between social housing and residential prices.

(8)whether it is close to MRT station (within 500 meters):

This variable is a dummy variable. The variable *mrt* is 1 when there are MRT station within 500 meters while *mrt* is 0 when there are no MRT station within 500 meters. The MRT is an important commute tool for people. The closer to the MRT, the shorter the commute time, and living quality will be better when commute time become shorter. So, this study anticipates a positive relationship between MRT and residential prices.

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(9)whether it is close to school(within 500 meters):

This variable is a dummy variable. The variable *schl* is 1 when there are elementary school within 500 meters while *schl* is 0 when there are no elementary school within 500 meters. A study by Lin (2004) shows that school districts do have a significant positive impact on housing prices. This study adopted the full elementary schools[3] announced by the New Taipei City Education Bureau in 2018 as a reference for excellent schools. For parents, it is easy to know from the newspaper media or the Education Bureau website whether the schools are full. However, for parents' information on school attendance and performance, parents generally lack proper channels to obtain such information. Therefore, in order to choose a popular school district, the information of the full school district is the easiest to obtain, which in turn affects the choice of parents to buy a house. Since New Taipei City Education Bureau did not announced full junior high schools, this study only adopted the full elementary schools as a reference. The closer to the school district, the more convenient and safe the student can go to school or pick up, so people often consider whether their home is located near the school district. Hence, this study anticipates a positive relationship between school and residential prices.

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[3] "Full Schools" means that the Education Bureau counts the number of first-year students who should be enrolled in the current academic year on April 25 of each year, and estimates the number of freshmen in each school according to the designated school district. When it is estimated that the average number of student in each class reaches a certain number (based on the principle set by the Education Bureau each year), it will be a "full school", approved by the Education Bureau.

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Table 3.2 Summary of the variables

Variables	Items	Unit	Expected signs
The dependent variable	log of the total price	dollar	
The independent variables	area	㎡	+
	floor	floor	+
	total floors	floor	+
	building age	year	-
	Distance to downtown	km	-
	building type	dummy variable	+/-
	close to MRT station or not		+
	close to excellent schools or not		+
	close to social housing or not		-

B. Data Source

The purpose of this study is to observe the relationship between social housing in New Taipei City and surrounding housing prices. According to the official website of the Social Housing of New Taipei City, there are 10 social housing are rented while there are 4 social housing are still under construction. In this research, the object will be the rented social housing, those which are still under construction will not be considered. Table 3.3 shows the list of the social housing in New Taipei City.

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Table 3.3 List of social housing in New Taipei city

Status	Name	Number of households
Leased	Linkou World Universiade Village Social Housing 林口世大運選手村社會住宅	3,408
	Sanchong House 1 三重 1 館	133
	Sanchong House 2 三重 2 館	119
	Sanchong House 3 三重 3 館	75
	Yonghe Youth Social Housing 永和青年住宅	7
	Yonghe Xiulang Police Station Youth Social Residence 永和秀朗派出所青年社會住宅	36
	Zhonghe Xiufeng Youth Social Housing 中和秀峰青年社會住宅	816
	Banqiao Fuzhong Youth Social Housing 板橋府中青年社會住宅	71
	Xinzhuang Xinfeng Youth Social Housing 新莊新豐青年社會住宅	76
	Sanxia Taipei University Youth Social Housing 三峽北大青年社會住宅	28

Source: official website of the Social Housing of New Taipei City, 2019

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The main source of the sample in this study is the real estate transaction price of New Taipei City from 2016 to 2018 collected from "real estate transaction price inquiry service" of the Ministry of the Interior. The original data of the sample includes 17 items of information such as administrative district, transaction year and month, building state, construction completion year, transaction land area, transaction floor area, total price, and so on. These data will be used as the internal property factors to observe the degree of influence on house prices. After eliminating the incomplete data, non-residential, data with remarkable columns, social housing transactions, first-floor transactions, townhouse, the total number of the sample is 12,012. As for other variables, the data of MRT station is collected from Taipei Metro and the "school" variable adopted the filled elementary schools announced by the New Taipei City Education Bureau in 2018 as a reference for excellent schools. Table 3.4 shows the list of the filled elementary schools.

Table 3.4 List of the filled elementary schools in 2018

Si Jhih District 汐止區	Baiyun Elementary School (白雲國小) Chingshan Elementary School(青山國小)
Sanchong District 三重區	Jimei Elementary School(集美國小) Bihua Elementary School(碧華國小)
Banqiao District 板橋區	Haishan Elementary School(海山國小) Jyuguang Elementary School(莒光國小)
Linkou District 林口區	TOUHU Elementary School(頭湖國小) Lilin Elementary School(麗林國小) Nanshih Elementary School(南勢國小) Sinlin Elementary School(新林國小)
Sanxia District 三峽區	Longpu Elementary School(龍埔國小) Beida Elementary School(北大國小) Taozihjiao Elementary School(桃子腳國小)
Luzou District 蘆洲區	Jhongyi Elementary School(忠義國小)
Danshuei District 淡水區	Sinshih Elementary School(新市國小)

Source: New Taipei City Education Bureau, 2018

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The main purpose of this study is to use the Hedonic price method to explore whether social housing affects housing prices. Therefore, this study first uses the TGOS address location system to obtain the latitude and longitude coordinates of the sample data, and then imports it into the Quantum Geographic Information System (QGIS), and uses QGIS analysis tools to determine whether there is a social house around the sample. The GIS analysis software is QGIS, licensed under the GNC (General Public License), and is an official program of the Open Source Geospatial Foundation (OSGeo). Its main features are basic access, modification, processing, storage, analysis and display of any form of spatial information, so it can be applied to many areas, such as homeland conservation, transportation management, market analysis or disaster prevention applications.

This study uses the GIS system's Buffer Analysis to process data. Buffer analysis is a basic GIS spatial operation. It automatically builds zones with a certain width around point, line, or region geometric objects according to a specified buffer distance. For example, in an environmental protection project, a zone can be drawn to include areas within a certain distance of a polluted river to represent the contamination area; a zone with a certain size can be drawn around an airport to define a non-residential area for public health concerns. According to the research result of 林祖嘉、林素菁(1993)、林素菁(2004)、楊宗憲、蘇倖慧(2011), MRT stations, schools and parks are all YIMBY facilities that have a positive impact on the price of real estate, and are mostly affected by 500 meters. Hence, this study will set 500 meters as the spatial range to analyze the impact of social housing, MRT station and school, using the current 10 rented social housing in New Taipei City for buffer analysis, finding sample of transactions around the social housing in the range of 500 meters. The result shows as below:

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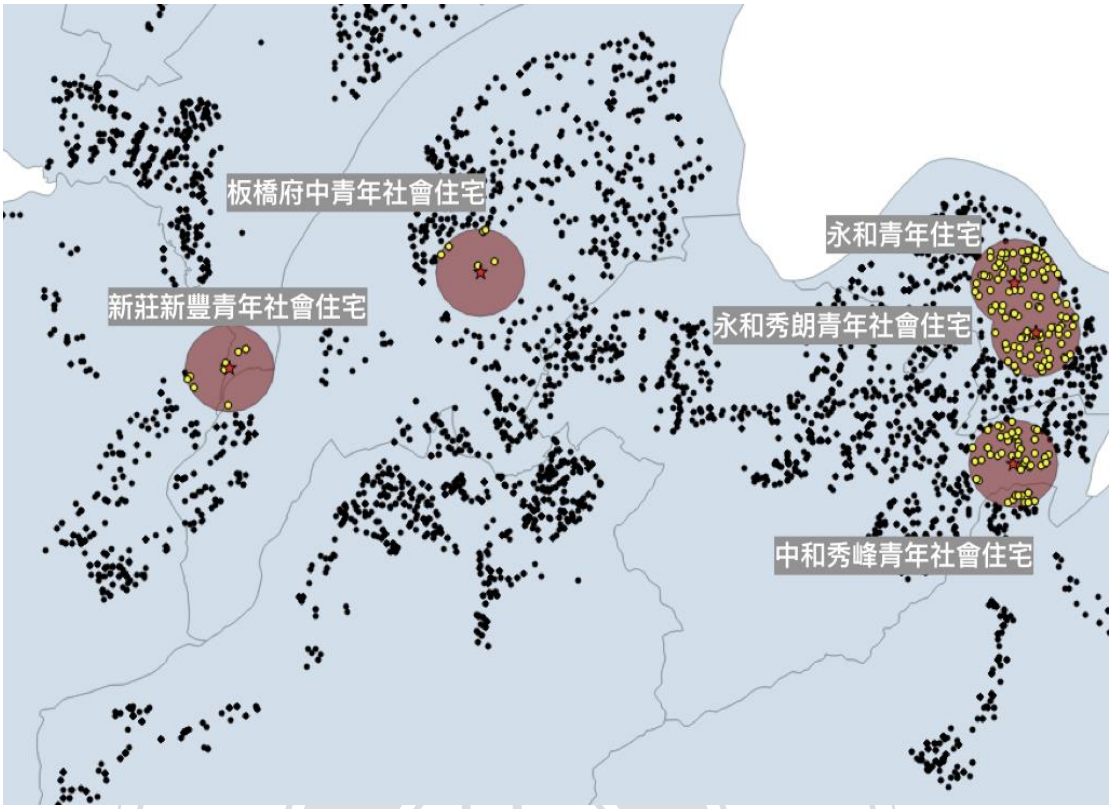

Figure 3.1 Diagram of buffer analysis of social housing and transaction data (part)

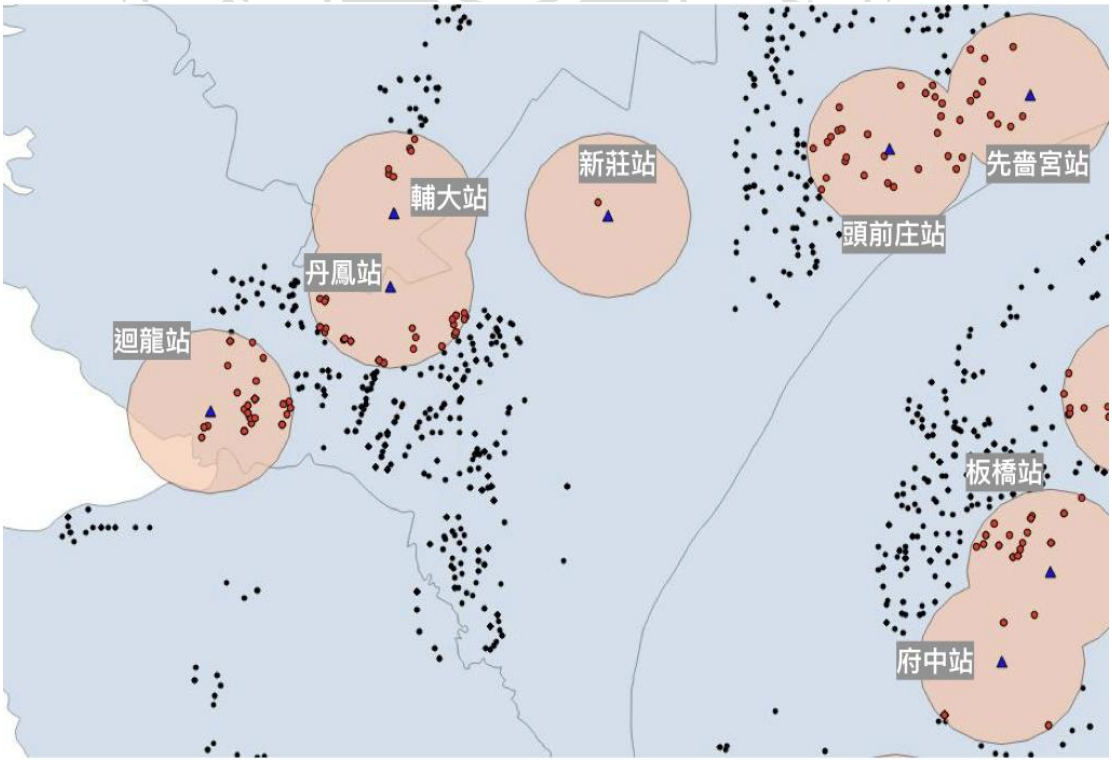

Figure 3.2 Diagram of buffer analysis of MRT station and transaction data (part)

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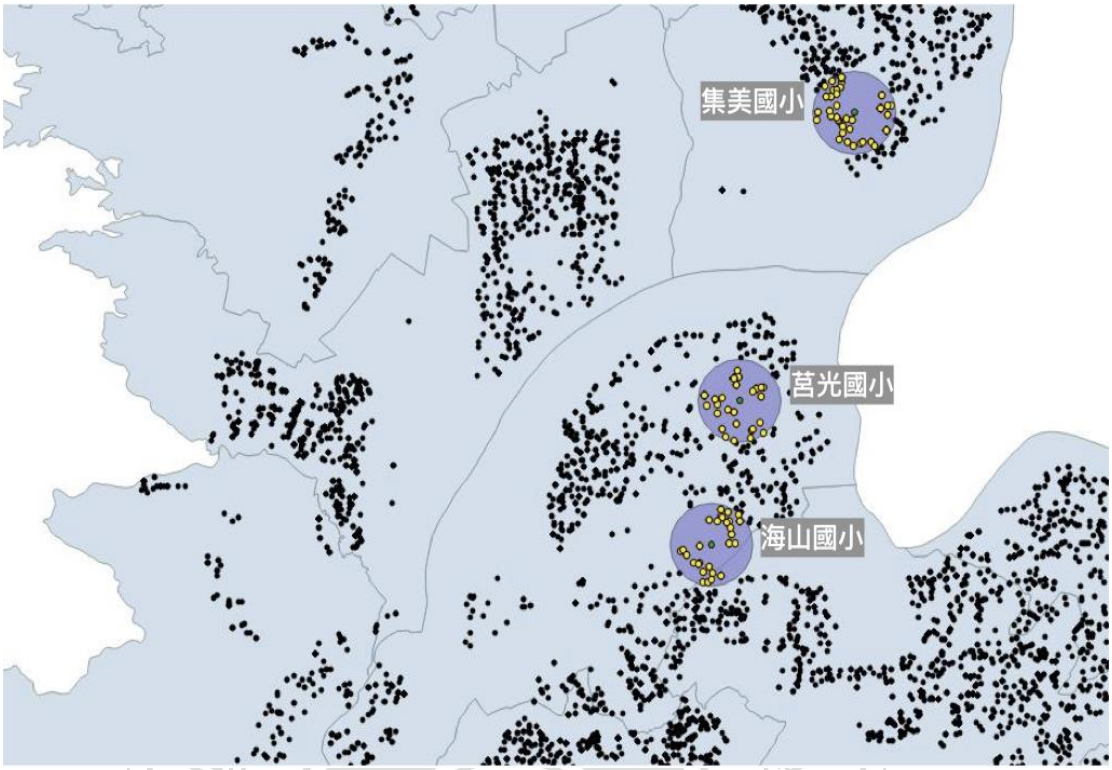

Figure 3.3 Diagram of buffer analysis of school and transaction data (part)

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The sample statistics are shown in Table 3.5. The average total price was 8.546 million. The average residential area is 94.7 square meters. The average housing age is 25.82 years. The average transaction floor is 5.45 floors. The average number of total floors is 9.12 floors. The average distance to the downtown is 9.53 km.

47.79% of the sample is building under 5 floors without elevator while 18.91% is building under 10 floors with elevator and 33.3% is building more than 10 floors with elevator. 17.49% of the sample is located within 500 meters of MRT station. 4.90% of the sample is located within 500 meters of school. 3.10% of the sample is located within 500 meters of social housing.

Table 3.5 Sample Statistics

Continuous Variable	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Total Price	412,165	68,770,000	8,546,656	3,933,938
Area	33.08	393.29	94.70	27.74
Floor	2	38	5.45	4.13
Total Floor	2	43	9.12	6.18
Age	0	55	25.82	11.17
Distance to downtown	2.17	41.41	9.53	4.81
Dummy Variable	**Description**		**Numbers**	**Percentage**
Building Type	under 5 floors without elevator		5,740	47.79%
	under 10 floors with elevator		2,272	18.91%
	over10 floors with elevator		4,000	33.30%
School	There are school within 500 meters		588	4.90%
MRT Station	There are MRT station within 500 meters		2,101	17.49%
Social Housing	There are social housing within 500 meters		372	3.10%

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IV.EMPIRICAL MODEL AND RESULTS

A.Pearson Correlation

Before performing regression analysis, to understand whether there is a linear correlation between variables, the relation between the two variables can be obtained by the "correlation coefficient". The "correlation coefficient" is a measure of the correlation of quantitative variables, also known as Pearson Correlation. Since the Pearson correlation is used to determine the correlation of continuous data, building type, MRT, school, and social housing are dummy variables in models, so they are not analyzed when Pearson correlation is used. Table 4.1 shows the result of Pearson Correlation.

Table 4.1 Result of Pearson Correlation

	lnprice	DisTP	floor	total floors	age	area
lnprice	1	-.547**	.095**	.123**	-.161**	.619**
DisTP	-.547**	1	.136**	.190**	-.276**	.021*
floor	.095**	.136**	1	.725**	-.445**	.039**
total floors	.123**	.190**	.725**	1	-.629**	.058**
age	-.161**	-.276**	-.445**	-.629**	1	-.179**
area	.619**	.021*	.039**	.058**	-.179**	1

**: P-value<0.01, *:P-value<0.05

It is found in the Pearson correlation that the Pearson correlation coefficient between the house price after the logarithm and the distance to city center is -0.547, showing a negative moderate correlation. The Pearson correlation coefficient between the house price after the logarithm and transaction area is 0.619, showing a positive moderate correlation. The Pearson correlation coefficient between the house price after the logarithm and the floor, the total number of floors and the building age is less than 0.3, showing a low correlation.

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Table 4.2 Pearson Correlation

The absolute value of Pearson correlation coefficient	Correlation
1	Perfect Correlated
0.7~0.99	Highly Correlated
0.4~0.69	Moderately Correlated
0.1~0.39	Modestly Correlated
0.01~0.09	Weakly Correlated
0	Non Correlated

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B. Empirical Results

Table 4.3 Estimation Results

The dependent variable	log(price)		
The independent variables	coefficient	VIF	marginal price
constant	15.534***		
floor	0.002*	2.11	17,093
total floors	0.004***	4.98	34,187
age	-0.005***	2.96	-42,733
area	0.009***	1.05	76,920
DisTP	-0.055***	1.17	-470,066
btype1	0.045***	2.15	384,600
btype2	0.071***	5.65	606,813
MRT	0.118***	1.07	1,008,505
school	0.077***	1.02	658,093
Sochou	0.025*	1.02	213,666
R^2= 76.21% Adj R^2= 76.19% ***:P-value<0.001, **:P-value<0.01, *:P-value<0.05 The average transaction price was $8,546,656			

The R^2 is 76.21%, indicating that the model has 76.21% of explanatory ability under the 95% confidence level and all independent variables are below 5% of the significant level. In terms of collinearity analysis, it can be seen from the VIF values that the VIF

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values of the respective variables are less than 10, meaning that the model has no serious collinearity problem.

After establishing the model, it is not possible to directly observe the marginal price. To find the marginal price of each feature, the coefficient estimated by the model must be converted. The calculation method is as followed:

Formula for continuous variable:

$$\hat{Pi} = \frac{\partial P}{\partial Xi} = \frac{\partial \log P}{\partial Xi} \times \frac{\partial P}{\partial \log P} = \hat{\alpha} \times P$$

Formula for dummy variable:

$$\hat{Pj} = \frac{\hat{Pj} - \hat{Pn}}{\hat{Pn}} \times P = (exp\left(\hat{\beta j}\right) - 1) \times P$$

$\hat{P}i$ and $\hat{P}j$ are marginal price of characteristic variable *i* or *j*. $\hat{\alpha}$ and $\hat{\beta j}$ are coefficient of characteristic variable *i* or *j* while P is the average price. Take variable "floor" for example, the calculation would be 0.002*8,546,656.

In terms of the characteristic variables of the Hedonic price model, most of them have a positive impact on housing prices, including transaction area, number of total floors, transaction floor, social housing, MRT, and school. On the other hand, building age and the distance to downtown has a negative impact on housing prices. The variables will be analyzed one by one below.

In terms of transaction area, for every additional square meter, the marginal price increases by 76,920 NT dollars. In terms of transaction floor, for every additional floor, the marginal price increases by 17,093 NT dollars. In terms of number of total floors, for every additional floor, the marginal price increases by 34,187 NT dollars. In terms of construction age, for every additional year, the marginal price decreases by 42,733 NT dollars. In terms of the distance to downtown, for every additional kilometer from Taipei Station, the marginal price decreases by 470,066 NT dollars. In terms of building type, the marginal price increases 384,600 NT dollars when it is under 10 floors with elevator and increases 606,813 NT dollars when it is over 10 floors with elevator. In terms of MRT station, the marginal price increases 1,008,505 NT dollars when there is

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MRT station within 500 meters. In terms of school, the marginal price increases 658,093 NT dollars when there is filled elementary school within 500 meters. In terms of social housing, the marginal price increases 213,666 NT dollars when there is social housing within 500 meters.

From the above results, social housing has a positive effect on the surrounding housing prices. However, compared with other variables in the model, its significance is weaker, and the effect on housing prices is also smaller than other variables.

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V.CONCLUSION

The issue of social housing is a problem that has been repeatedly dialectical by the whole people. On the one hand, it is to protect the welfare of the disadvantaged groups. On the other hand, it is necessary to consider the problems caused by the disadvantaged groups, including safety problem, sanitary conditions, and so on. In 2011, the Executive Yuan promoted the “Social Housing Short-Term Implementation Plan” and selected five pilot sites in Taipei City and New Taipei City. Then, in 2014, the “Medium and Medium-Term Promotion Plan for Social Housing” was approved. It is planned to build 15,100 social housing units by 2023. However, due to the negative impression of the past public housing, in the process of the government's construction of social housing in recent years, residents near construction base often opposed, and they are worried that the surrounding housing prices will fall. However, the existence of social housing for the disadvantaged group is not limited to physical and mental obstacles. It is also applicable to the economically disadvantaged such as young students, the fresh-started workers, and the newly-married couples who have just established a family. Social housing should not be considered NIMBY facility, but a policy to promote social development.

The empirical study found that the main reasons for the impact of housing transactions in New Taipei City are determined by the size of the residential area and the convenience of transportation. In terms of housing demand, people still take the housing conditions and transportation convenience as the main considerations. As for social housing, it is proved to have a positive impact on the surrounding housing prices, breaking the impression of NIMBY facility. In the past, social housing was mainly targeted at economically disadvantaged groups, making an impression as slum, then gradually seen as a NIMBY facility. The reason why social housing nowadays has no negative impact on house price is probably because that the target of social housing does not focus on economically disadvantaged people anymore but young people who just graduated from school and new to the society. Compared to economically disadvantaged groups, people usually don’t have negative thoughts about young people. In addition, the government also focuses on better building design and better operational management, making social housing just like normal residential building.

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黃怡潔、江穎慧、張金鶚(2017) studied the impact of four different types of social housing in Taipei City on the surrounding housing prices from July 2012 to September 2015. The empirical results show that the housing prices where there are early built public housing and rental public housing are significantly low. The rise and fall of the total price of nearby residential houses where there are for-sale public housing is not significant. And the newly built public rental housing has caused a significant increase in the price of surrounding houses. The social housing used in this study are newly built public rental housing and the effect on house price is positive, which is same as the result in Taipei City studied by 黃怡潔、江穎慧、張金鶚(2017).

In the future, the government should set up spaces and activities for neighborhood communication when planning social housing, so that the neighborhood can have a platform for exchanges among newcomers, thereby breaking the barrier between people. At the same time, in the process of communication, the government should hold a briefing on social housing, and declare the residential policy. On the part of residents, it should be understood that the purpose of the housing policy is to provide everyone with the opportunity to enjoy the benefits, and the government will give a helping hand when people is in need.

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