



THE IMPACT OF LUXURY HOUSING ON NEIGHBORHOOD HOUSING PRICES IN TAIPEI CITY



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ABSTRACT

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This study investigated whether a decision to construct luxury housing can help increase neighborhood housing prices. The difference-in-difference method was used in the analysis. Housing transaction data from 2008 to 2011 were used in the analysis. According to the empirical results, after eliminating the common growth in prices (10.6%) between the neighborhood in which luxury housing was to be built and the other non-luxury neighborhood, the real gap in the housing prices caused by the luxury housing was 11.2%. This suggests that luxury housing has spillover effects on neighborhood housing prices and, specifically, can help to increase neighborhood housing prices. Furthermore, the results showed that housing prices in the neighborhood in which the luxury housing was to be built were inversely proportional to the distance from the luxury housing.

Contribution/ Originality: This suggests that luxury housing has spillover effects on neighborhood housing prices and, specifically, can help to increase neighborhood housing prices. Furthermore, the results showed that housing prices in the neighborhood in which the luxury housing was to be built were inversely proportional to the distance from the luxury housing.

1. INTRODUCTION

In recent years, Taiwan's real estate market has been dominated by high-priced housing products, which are advertised as being built with the highest quality building materials and equipment in the best locations, with large floor areas, good planning and strong management. Moreover, due to the intense competition of the housing sales market, numerous luxury housing development projects are currently in progress. Thus, the effects of such luxury housing have become a focus of concern. With regard to high-priced housing, the Taipei City Revenue Service defines a house with a total transaction price above 80 million NTD as a "senior house," which would more commonly be described as luxury housing. According to Lin and Jou (2005) luxury housing refers to houses with exceptional landscapes, locations and other rare space-related resources, or houses with a high total price, high floor area, high quality facilities and high profile. Almatarneh (2013) suggested that real estate developers distinguish

between luxury housing and general housing through their advertisements of various housing characteristics, such as design, planning, and architectural concepts, thereby further strengthening the position of luxury housing in the minds of the public. The unique and irreplaceable features of luxury housing units have a very important impact on the real estate market.

The choice of a good living environment depends not only on the characteristics of the home itself, but also on the characteristics of the given neighborhood residential environment. DiPasquale and Wheaton (1996) indicated that when the appearance of a residential area becomes more beautiful, the quality of life in that neighborhood will become more attractive, resulting in positive spillover effects on neighborhood housing prices. Bourassa *et al.* (2004) proposed that attractive buildings increase the value of the real estate in the surrounding neighborhoods, and that attractive luxury housing may also attract more residents, including those with high incomes, as well as members of the political and business elite with high socioeconomic statuses. Moreover, people may select their places of residence to maintain their images by getting close to people with high incomes and social statuses (Cialdini *et al.*, 1976). Ooi and Le (2013) argued that both newly developed buildings and luxury housing may have positive external effects or spillover effects on neighborhood housing. The architectural style of luxury housing is generally different from that of general buildings. In addition to their innovative and stylish appearances, luxury housing units may create price spillover effects through the beautification of the neighborhood environment and high sales prices, thereby affecting the average neighborhood housing price.

This study aims to investigate whether luxury housing has such spillover effects on neighborhood housing prices. It adopts the difference-in-difference method (DD) to analyze the impact of luxury housing on neighborhood housing prices before and after the obtainment of a construction license. This method can accurately estimate the impact of a single event on two groups. After eliminating the common growth trend of the treatment group and the control group, as well as other unobserved influential factors, the real impact of luxury housing buildings on neighborhood housing prices can be more effectively estimated.

The purposes of this study are: (1) to discuss the differences in housing prices between a neighborhood in which luxury housing is to be built and another, non-luxury neighborhood before the announcement of luxury housing construction, as well as the differences in neighborhood housing prices after the announcement of luxury housing construction; that is, to determine whether luxury housing spillover effects have a greater impact on the neighborhood housing prices in which the luxury housing is actually built than on the prices in other neighborhoods; and (2) to determine whether, after a decision to construct luxury housing has been made, there are different impacts on neighborhood housing prices based on the distance from the luxury housing. If the impact of the luxury housing on neighborhood housing price decreases with increasing distance from the luxury housing, it means that the luxury housing spillover effects will decrease over increasing distances from the luxury housing.

2. LITERATURE REVIEW

The impact of luxury housing on neighborhood housing prices can be explained by spillover effects and amenity effects. The quality of a living environment depends not only on the characteristics of a home itself, but also on the characteristics of the given neighborhood residential environment. Boyle and Kiel (2001) proposed that environmental externalities such as a neighborhood's air quality, water quality, and unpopular land use are likely to affect neighborhood housing prices. Des Rosiers *et al.* (2002) found that beautification of landscaped curbs will increase neighborhood real estate prices by about 4.4%. Bourassa *et al.* (2004) argued that attractive buildings can increase neighborhood real estate prices by about 37% and that the unique and attractive improvements in a neighborhood can increase neighborhood real estate prices by about 27%. In contrast, the prices of housing in neighborhoods of poorer environmental quality can be reduced by 51%.

The prices of houses in a neighborhood with luxury housing are affected by that luxury housing because people are attracted by things of value higher than their intrinsic value and seek associate themselves with them. (Cialdini

et al., 1976) called this effect the basking in reflected glory (BIRGing) effect, arguing that people associate with successful people to create a positive self-image and better evaluations from others. According to Tesser (1988) when people become closer to outstanding or superior people, they feel honored with improved self-evaluations. Similarly, luxury housing will also attract those with high socio-economic status to live in a given neighborhood neighborhood effect (DiPasquale and Wheaton, 1996; O'Sullivan, 2000).

According to a review of the literature on empirical estimation methods, in the past, the hedonic price method was generally used for estimating the impact of improved neighborhood environment quality on housing prices. However, in recent years, where the occurrence of a specific event has improved the quality of a specific neighborhood environment to affect the neighborhood housing price, the estimation of cause and effect has typically been accomplished by using the difference-in-difference method. The advantage of the method is that it can review the impact of the announcement of a specific policy or the construction of a specific building on the neighborhood.

Kiel and McClain (1995) explored the impact of the establishment of waste incineration plants on the price of the housing in the North Andover area by setting the announcement times for the establishment of the incineration plants from 1979 to 1980 and comparing the housing prices as of 1978 and 1981. Residential housing outside of the perimeter of 3 miles from the incineration plants was the control group, while houses within the perimeter of 3 miles from the incineration plants were regarded as the treatment group. The research findings suggested that the difference-in-difference price was 11,863.9 USD.

Kavetsos (2012) analyzed the effect of the announcement of hosting the Olympic Games on London housing prices by using five regions hosting Olympic events as the treatment group and the rest of the regions of London as the control group. The results, estimated by using the difference-in-difference method, indicated that the housing prices in the five administrative regions (Greenwich, Hackney, Newham, Tower Hamlets, and Waltham Forest) increased by 2.1% to 3.3% after the announcement.

Dehring *et al.* (2007) explored the impact of the announcement that a new stadium would be constructed on the local housing prices in Dallas-Fort Worth. The sample data included the residential housing sales data for Dallas and Arlington from January 2004 to March 2005. The difference-in-difference method was adopted to analyze the impact of the announcement of building a new stadium on local housing prices. The research findings suggested that the average housing price decreased by 1.5% after the announcement that a new stadiums would be built as the tax burden on the local community was increased to subsidize the construction. Therefore, the local housing prices dropped in the short term.

Dubé *et al.* (2011) applied the difference-in-difference method to estimate of the impact of rapid bus transit service in Quebec on residential housing prices, finding that the residential housing prices did not change significantly. Heintzelman (2010) employed the difference-in-difference method in the analysis of CPA (community preservation act) implementation in communities across Massachusetts on local real estate prices by using communities implementing CPA as the treatment group and communities not implementing CPA as the control group. According to the estimation results, the local real estate prices decreased by about 1.5% after the implementation of CPA. Compared to many previous research methods such as the hedonic price method, the difference-in-difference method can eliminate the possible interference of unobserved factors on housing prices to avoid estimation bias, and thus demonstrate the real impact on neighborhood housing prices.

3. EMPIRICAL MODEL

3.1. Empirical Model Settings

The difference-in-difference method is a research method now widely used in the field of micro econometrics. The method assumes that the treatment group and the control group are the groups that will be compared both before and after a policy change, where the treatment group is the group affected by the policy change and the control group is a group not affected by the policy change. The purpose of using the method is to evaluate the

impact of the policy. Through time delineation, that is, by examining certain periods before and after the occurrence of the specific event or policy announcement, as well as by comparing the differences between the control group and the treatment group. An analysis that uses the difference-in-difference method can effectively control for any systematic differences caused by potential selection bias (Wooldridge, 2009).

The estimation of luxury housing spillover effects can be made by comparing the differences in housing prices of a control group and a treatment group after the occurrence of a specific event, namely, the obtainment of a construction license for the luxury housing. In general, real estate developers can legally sell housing products after obtaining the relevant construction license, and can thus pre-sell the housing products before the completion of construction. Such a pre-sales method is very common in Asian countries and regions. Lai *et al.* (2004) and Munneke *et al.* (2011) used the time of obtaining the construction license as the delineation benchmark. This study also used the date on which the official construction license for the luxury housing in question was obtained as the time at which the decision to construct the luxury housing was made. With regards to studies classifying the treatment group and the control group by distance, Liang (2009) and Dempsey and Plantinga (2013) classified the groups according to a radius of 500 meters; Voicu and Been (2008) compared the housing prices in the research area of a radius between 500 feet and 1000 feet (about 150~300 meters). This study classified houses located within the radius of 500 meters from the luxury housing as the treatment group and those outside the radius of 500 meters from the luxury housing as the control group in order to discuss the differences in the impact on housing prices in terms of the distance from the luxury housing. The settings of the empirical model used are shown as follows in Eq. (1):

$$\ln P_{it} = \beta_1 + \beta_2 TIME_t + \beta_3 TREAT_t + \delta(TIME_t \times TREAT_t) + \sum_{j=1}^n \gamma_j X_{jit} + e_{it}, \quad (1)$$

where,

$\ln P_{it}$: the natural logarithm of the transaction price of house No. i at time t .

β_1 : intercept.

$TIME_t$: a dummy variable, where if house No. i is traded after obtaining the construction license, it is valued as 1, and otherwise, it is valued as 0.

$TREAT_t$: a dummy variable, where if house No. i is located in the luxury housing neighborhood, it is valued as 1, and otherwise, it is valued as 0.

X_{jit} : other explanatory variables that may affect the housing prices including basic housing properties and neighborhood environment attributes.

β_2 : the impact coefficient of obtaining the construction license for luxury housing on the housing prices.

β_3 : the impact coefficient of neighborhood luxury housing on the housing prices.

δ : the impact coefficient of difference-in-difference.

γ_j : the impact coefficient of other explanatory variables.

e_{it} : an error term; in line with normal distribution, its average is 0.

In order to analyze whether the housing prices of sub-samples within the treatment group were different due to their different distances from the luxury housing, samples within the treatment group were divided in terms of their distances from the luxury housing as follows: distances within 100 meters, distances of 100 meters to 300 meters, distances of 300 meters to 500 meters.

3.2 Variable Selection Descriptions

Ihlanfeldt (2007), Matthews and Turnbull (2007) and Andersson *et al.* (2010) divided the residential housing attributes into basic attributes, including the hedonic price variables in the unit of household or building, and housing neighborhood environmental attributes, including environmental factors and the accessibility of public

transport facilities. This study used the basic hedonic attributes as the internal attributes. Secondly, this study used Arc GIS software 10.1 to compute the nearest distances of the houses to the neighborhood environment attributes (e.g., MRT station, railway station, primary school, junior high school) as the external housing attributes. Thirdly, this study also explored the difference-in-difference attributes. The definitions of various variables are shown below in Table 1.

(1) Dependent Variables

This study used the natural logarithm of the housing transaction total price as the dependent variable ($\ln PRICE$). Cohen and Coughlin (2008), Kavetsos (2012) and Gibbons *et al.* (2013) argued that the total transaction price as the dependent variable has more complete economic implications as compared to the dependent variable of the transaction unit price in representing the housing price. Moreover, many scholars, including Sirmans *et al.* (2005), Lipscomb and Farmer (2005) and Zietz *et al.* (2008) have suggested that the logarithm of dependent variable price has been confirmed to be able to reduce the data heterogeneity and avoid the estimation by using the quantile regression approach. As such, this study adopted the log-linear function type as the regression model.

(2) Basic Housing Properties

The residential area ($AREA$) is the actual registered area of the housing subject and is a continuous variable. In general, under the same assumed conditions, if the area is greater, the housing price will be higher. McMillen and Redfearn (2010), Landry and Jahan-Parvar (2011) and Abbott and Klaiber (2011) found that residential area has a positive impact on housing price. The housing age (AGE) refers to the number of years since the year that construction of the building was completed to the year of the transaction. It is also a continuous variable, and directly reflects the depreciation and replacement cost. Under the same assumed conditions, if the housing age is older, the facilities and building materials will deteriorate over time, resulting in a reduced housing price. Osland (2010), Carrillo (2012) and Bin and Landry (2013) argued that housing age and housing price were negatively correlated. It is expected that housing age has a negative impact on housing price. However, the depreciation due to housing age does not occur in a rigid linear fashion as the depreciation is faster in the beginning. If the regression model adopts the variable of housing age only, only the linear change caused by housing age is observed. Therefore, the addition of the variable of housing age squared ($AGES$) is used to observe the non-linear change of depreciation. Kadish and Netusil (2012) and Bin and Landry (2013) argued that housing age squared and housing price were positively correlated. It is expected that housing age squared has a positive impact on housing price.

The number of rooms ($ROOM$) is related to the internal layout of the housing subject. It is a continuous variable. If the residential area remains unchanged, a greater number of rooms results in a higher likelihood of using the internal space. Sirmans *et al.* (2005), Hansen *et al.* (2006), McMillen and Redfearn (2010) and Araya and Iturra (2013) suggested that number of rooms and housing price were positively correlated. It is expected that the number of rooms has a positive impact on housing price. The number of living rooms ($LIVEROOM$) is related to the internal layout of the housing subject measured by the unit of living rooms. It is a continuous variable. When the number of living rooms is greater, it means the area of the house is larger, and the price of the house will be higher. This attribute will be directly reflected in the house purchasing cost. Hong and Lin (1999) and Huang *et al.* (2010) found that the housing price would be higher if the number of living rooms was larger, indicating that the number of living rooms and housing price were positively correlated. It is expected that the number of living rooms has a positive impact on housing price. The number of bathrooms ($BATH$) is also related to the internal layout of the housing subject. It is also a continuous variable. According to a review of previous studies on price models, it is generally accepted that the number of bathrooms has a positive impact on housing price (Anselin and Lozano-Gracia, 2008; McMillen and Redfearn, 2010; Baltagi and Bresson, 2011). It is expected that the number of bathrooms has a positive impact on housing price.

The residential floor refers to the floor of the housing subject. It is set as a dummy variable. *FLOOR1* means that the house is located on the first floor; otherwise, it is set as 0. Alternatively, *FLOOR4* means that the house is located on the fourth floor; otherwise, it is set as 0. Houses on the first floor can usually be used as shops or for other commercial purposes, and thus there will be an effect of increasing the housing price. Therefore, it is expected that being located on the first floor has a positive impact on housing price. As for houses on the fourth floor, the pronunciation of the number “four” sounds similar to the word for “death” in Chinese, so people in Taiwan are generally less willing to live on the fourth floor. Therefore, the utility ratio of the fourth floor is generally lower (Yang and Su, 2011). Lin *et al.* (2011) argued that a location on the fourth floor thus has a negative impact on real estate price. It is expected, then, that a location on the fourth floor has a negative impact on housing price.

This study uses data from residential samples including buildings and apartments. In general, a building of six or more floors with elevators is regarded as a building while a building of five or fewer floors without elevators is regarded as an apartment. The housing type (*TYPE*) is set as a dummy variable. It is set as 1 for a building and 0 for an apartment. The building and apartment are common types of condominium housing in Taiwan. In recent years, most of the newly built buildings have steel structures. In contrast, apartments generally do not have steel structures. Moreover, apartments usually have only four or five floors. Buildings have more than six floors and also have elevators. Therefore, the construction costs of buildings are higher than those apartments (Lin and Ma, 2012). It is expected that prices of buildings are higher.

(3) Neighborhood Environment Attributes

Concerning the distance to MRT station variable, this study considered MRT stations in Taipei City. Since the MRT was put into service, the cost of commuting time has been reduced and the accessibility of neighborhoods has been improved, making urban life more convenient and better; hence, MRT may have a significant impact on housing price. Ahlfeldt and Maennig (2010) found that increasing the distance to an MRT station may lead to a reduced housing price. It is expected that the nearest distance to an MRT station has a negative impact on housing price. Regarding the distance to a railway station (*TRAIN*) variable, this study considered several railway stations including Taipei Station, Wanhua Station, Songshan Station, and Nangang Station. As a transportation node, a railway station can promote the development of commercial activities in the surrounding areas, and living facilities closer to railway stations are more numerous and convenient. Gibbons *et al.* (2014) found that the distance to a railway station is inversely proportional to housing price. It is expected that the nearest distance to a railway station has a negative impact on housing price. In terms of the distance to school (*PRIM*, *JUIN*) variables, the schools considered in this study included primary schools and junior high schools. As schools provide living and recreational space for residents, and provide families with children convenient and safe access to education, the distance to a school is regarded as one of the major factors to consider in purchasing a house. Gibbons *et al.* (2014) found that a housing price would be higher if it was closer to a school, as they were negatively correlated. It is expected that the distance to a school has a negative impact on housing price.

(4) Difference-in-Difference Attributes

As for the time when the luxury housing construction license was obtained (*TIME*) variable, the sample period of this study was from January 1, 2008, to December 31, 2011. The sample data were divided into samples from before a construction license was obtained and samples from after a construction license was obtained by the benchmark period for obtaining such construction licenses of July to December, 2010. It is a dummy variable. The value of the variable for samples during the period from January 1, 2008, to June 30, 2010 (that is, before a license was obtained) is set as 0, while the value of the variable for samples during the period from January 1, 2011, to December 31, 2011 (that is, after a license was obtained) is set as 1. The appearance of luxury housing is more attractive than that of general housing, and it can beautify the surrounding environment; therefore, it can improve

the quality of a neighborhood environment to make the neighborhood more attractive (O'Sullivan, 2000). In addition, it can attract people of high social and economic status to move in. As a result, regular people and investors may follow the lead of celebrities or others of high socioeconomic status in choosing to live in the neighborhood or invest in the area. People may also have higher self-evaluations if they live in a neighborhood with luxury housing (Cialdini *et al.*, 1976; Tesser, 1988) resulting in increased housing prices for the whole community. It is thus expected that obtaining a construction license for luxury housing has a positive impact on housing prices.

The luxury housing neighborhood (*TREAT*) variable refers to the number of houses that are really located in the radius of the luxury housing. It is a dummy variable. If the sample is located within the radius of the luxury housing (the treatment group), the value is set as 1; otherwise (the control group), it is set as 0. This study sought to explore the difference between samples within the radius of 500 meters from the luxury housing and samples outside the radius of 500 meters from the luxury housing in terms of housing price. The development of luxury housing may result in positive spillover effects on a neighborhood. Bourassa *et al.* (2004) argued that attractive buildings can increase neighborhood housing prices. The neighborhood environment can improve the neighborhood quietness and comfort to create a positive impact on neighborhood housing prices. In addition, based on the social attributes of Taiwanese society and the extent to which Taiwanese people typically seek to bask in the glory of the high status people and positive events of a neighborhood, it is expected that neighborhood luxury housing has a positive impact on housing price. The time of obtaining construction license \times luxury housing neighborhood (*TIME* \times *TREAT*) variable is an interactive variable referring to the interaction between the time of obtaining the construction license and being in the neighborhood of luxury housing. After obtaining the construction license, if a house is located in the luxury housing neighborhood, luxury housing can beautify the neighborhood environment to improve the neighborhood environmental quality. Moreover, the architectural design of luxury housing can improve the neighborhood housing landscape to result in a positive impact on the neighborhood. Ooi and Le (2013) explored the impact of new development projects on neighborhood housing prices. Kavetsos (2012) discussed the impact of newly built Olympic stadiums on neighborhood housing prices. Both of those studies applied the difference-in-difference method and predicted that newly developed or newly built buildings have a positive impact on neighborhood housing prices. It is expected that the time to obtain the construction license \times luxury housing neighborhood has a positive impact on housing price.

4. DATA SOURCE DESCRIPTIONS AND DESCRIPTIVE STATISTICS

4.1. Data Source Descriptions

In this study, the residential transaction data source used was the "Taiwan Real Estate Transaction Bulletin" published by the Giga House website of the Taiwan Real Estate Transaction Center (Taiwan Real Estate Portal). The data period was from January 1, 2008, to December 31, 2011. Focusing on Taipei City, this study obtained a total of 10,930 samples. Taiwan Real Estate Portal started to provide a transaction information query service in 2005. The data were collected from well-known real estate agencies in Taiwan including Sinyi Realty, Pacific Realtor, Century 21 Real Estate LLC, Chinatrust Real Estate, H&B Real Estate, Dafengfu Real Estate, Good Morning Rehouse, ERA Taiwan Master Franchise, Ever Spring Real Estate, and Chiau Mau Realty, and the data were about transactions with a guarantee of performance. This study obtained the transaction data regarding buildings and apartments from the bulletin, including housing attributes such as the housing transaction price, floor area, housing age, and number of floors. As the data from the website were not limited only to housing transaction data, this study eliminated any data regarding non-residential housing transactions including transactions involving land, parking spaces, factories, offices, and stores, as well as any samples with incomplete information. This study eliminated the top and bottom 5% of samples of housing prices in various administrative regions to avoid the effect of outliers on the statistical computational results. Finally, 8,871 samples were used for the empirical analysis. According to luxury housing standards set by the Taipei City Revenue Service and the central

bank of Taiwan,¹ -- that is, independent building, luxurious appearance, great location, good landscape, few households on each floor, parking space for each household, strict security and comprehensive management -- the total price of such a house should be 80 million NTD and above, and the unit price of each *ping* should be 1 million NTD and above. After cross-validation, this study collected real cases of luxury housing in Taipei City. During the sampling period from July to December 2010, the luxury housing cases with construction licenses were selected as the samples in this study. The five cases of luxury housing for this study were located in various districts of Taipei City, including the Zhongzheng, Songshan, and Da'an districts. The sources of the data on the luxury housing cases included the Ministry of Interior real estate transaction price query service website, the official websites of various construction companies and other housing information websites on the Internet.²

Table-1. Variable Descriptions

Variable Name	Variable Code	Variable Definition	Expected Symbol
Dependent variable:			
Housing price	<i>ln PRICE</i>	The natural logarithm of the total price of the house (including parking space). (original housing price unit: NTD, 10,000)	
Basic housing properties:			
Residential area	<i>AREA</i>	The residential area of the subject building as registered with the land authorities (including main building, auxiliary buildings, public facilities), measured in pings. (1 ping equals 35.58 sq. ft.)	+
Housing age	<i>AGE</i>	The time from the year of completion and getting a permit to use to the year of transaction, measured by year.	--
Housing age squared	<i>AGES</i>	The variable of housing age squared is added to observe the non-linear changes in depreciation. It is expected that the symbol of the variable of the housing age squared is positive.	+
Number of rooms	<i>ROOM</i>	The number of rooms of the building measured by room	+
Number of living rooms	<i>LIVEROOM</i>	The number of living rooms of the building, measured by room	+
Number of bathrooms	<i>BATH</i>	The number of bathrooms of the building, measured by room	+
Residential floor	<i>FLOOR</i>	Residential floor is a dummy variable. If the subject is located on the first floor, its value is set as 1; otherwise, its value is set as 0.	+
	<i>FLOOR4</i>	Residential floor is a dummy variable. If the subject is located in the fourth floor, its value is set as 1; otherwise, its value is set as 0.	--
Housing types	<i>TYPE</i>	Housing type is a dummy variable. If the house is located in a building, its value is 1, and otherwise, it is 0.	+
Neighborhood environment attributes:			
Distance to MRT	<i>MRT</i>	Continuous variable, the nearest distance as measured by GIS from the house to the MRT. Unit: meters	--
Distance to railway station	<i>TRAIN</i>	Continuous variable, the nearest distance as measured by GIS from the house to the railway station. Unit: meters	--
Distance to primary school	<i>PRIM</i>	Continuous variable, the nearest distance as measured by GIS from the house to the primary school. Unit: meters	--
Distance to junior high school	<i>JUNI</i>	Continuous variable, the nearest distance as measured by GIS from the house to the junior high school. Unit: meters	--
Difference-in-difference attributes:			
time to obtain the luxury housing construction license	<i>TIME</i>	The time to obtain luxury housing construction license is a dummy variable. The sample period was from January 1, 2008, to December 31, 2011. The benchmark was the period from July to December 2010. The value of samples within the period from January 1, 2011, to December 31, 2011, is set as 1, while the value of samples within the period from January 1, 2008 to June 30, 2010, is set as 0.	+
luxury housing neighborhood	<i>TREAT</i>	Luxury housing neighborhood is a dummy variable. If the house is located within the radius of 500 meters from the luxury housing, its value is set as 1; otherwise, it is set as 0.	+
time to obtain the luxury housing construction license × luxury housing neighborhood	<i>TIME × TREAT</i>	The interactive variable of the time to obtain the luxury housing construction license and luxury housing neighborhood. The variable's coefficient is the difference-in-difference estimation coefficient.	+

¹Taipei City Revenue Service, standards for high end housing, retrieved on 12 September, 2013, from:

<http://www.tpctax.taipei.gov.tw/ct.asp?xitem=22189009&CtNode=22084&mp=103011>

² Ministry of Interior, real estate transaction price query service network, retrieved on 21 June, 2013, from: <http://lvr.land.moi.gov.tw/N11/homePage.action>.

Myhousing, retrieved on 21 June, 2013, from: <http://www.myhousing.com.tw>. Blog, retrieved on 23 June, 2013, from: <http://www.park.com.tw/index.php>

4.2. Descriptive Statistics

According to the descriptive statistics in Table 2, the average housing price was 13.978 million NTD. The average residential area (*AREA*) was 31.63 *ping* (1 *ping* equals 35.58 sq. ft.). The average housing age (*AGE*) was 20.86 years. The average number of rooms (*ROOM*) was 2.47 rooms. The average number of living rooms (*LIVROOM*) was 1.77 rooms. The average number of bathrooms (*BATH*) was 1.48 rooms. The residential floor being on the first floor (*FLOOR*) accounted for 6.0% of the sample houses, the residential floor being on the fourth floor (*FLOOR4*) accounted for 21.0%, and the residential floor being on the other floors accounted for 73.0%. Regarding housing types (*TYPE*), buildings accounted for 56.0%, while apartments accounted for 44.0%. The average nearest distance to an MRT station (*MRT*) was 588.55 meters. The average distance to the nearest railway station (*TRAIN*) was 3,713 meters. The average distance to the nearest primary school (*PRIM*) was 401.92 meters. The average distance to the nearest junior high school (*JUNI*) was 586.60 meters.

Table-2. Descriptive statistics (N=8,871)

	Mean	Standard deviation	Minimum value	Maximum value
<i>PRICE</i>	1397.83	997.18	44.00	23100.00
<i>AREA</i>	31.63	15.93	5.67	174.43
<i>AGE</i>	20.86	11.62	0.10	49.90
<i>AGES</i>	570.23	490.04	0.01	2490.01
<i>ROOM</i>	2.47	0.91	1	5
<i>LIVROOM</i>	1.77	0.49	1	5
<i>BATH</i>	1.48	0.60	1	5
<i>FLOOR</i>	0.06	--	0	1
<i>FLOOR4</i>	0.21	--	0	1
<i>TYPE</i>	0.56	--	0	1
<i>MRT</i>	588.55	461.25	2.71	5146.07
<i>TRAIN</i>	3713.33	2524.00	53.75	11284.55
<i>PRIM</i>	401.92	226.59	0.07	2275.23
<i>JUNI</i>	586.60	324.91	0.24	3099.66

5. EMPIRICAL RESULTS

Table 3 Model 1 illustrates the OLS estimation regression results. Its *F* statistic value was 868.991, having reached the 1% significance level, and \bar{R}^2 was 62.8%. This study applied VIF (variance inflation factor) in judging whether there is a serious collinearity problem in between independent variables. The results suggest that the VIF values of the variables were below 10. According to the suggestions of [Neter et al. \(1996\)](#) VIF values below 10 mean that there is no serious collinearity problem between independent variables.

OLS estimation results may have the problem of error term heterogeneity. Therefore, this study conducted the Breusch-Pagan test of the regression model to determine whether the model residuals have heterogeneity by using

$LM = n \times R^2 \sim \chi^2_{(p-1,95\%)}$ to determine whether the model had heterogeneity. The LM statistic value was 453.45,

which is greater than the critical value of $\chi^2_{(17-1,95\%)}$ at 26.296, suggesting that the model residual had heterogeneity.

When a model has the heterogeneity problem, GLS can be used in the estimation of the regression parameters. This study illustrates the regression coefficients of GLS estimation as follows.

Table 3 Model 2 illustrates the GLS estimation results. Its F statistic value was 955.221, having reached the 1% significance level. \bar{R}^2 was 64.9%, suggesting that the regression model fitness was good. Regarding VIF values, except for housing age and its square, the rest of the VIF values were below 10, suggesting that there was no serious collinearity problem between the independent variables.

Regarding basic housing properties, the residential area estimation coefficient was 0.017, having reached the 1% significance level. This means that if the residential area is increased by 1 *ping*, the housing price will increase by 1.7%. The housing age estimation coefficient was -0.016, having reached the 1% significance level. This means that if the housing age is increased by one year, then the housing price will decrease by 1.6%. Its square estimation coefficient was 0.001, having reached the 1% significance level. This means that an older housing age can result in a lower housing price. However, the decrease is at the marginal decrease state. The number of rooms' estimation coefficient was 0.027, having reached the 1% significance level. This means that an increase of one room can result in an increase of the housing price by 2.7%. The number of living rooms estimation coefficient was 0.082, having reached the 1% significance level. This means that an increase of one living room can result in an increase of housing price by 8.2%. The number of bathrooms estimation coefficient was 0.136, having reached the 1% significance level. This means that an increase of one bathroom would result in a housing price increase of 13.6%. The Floor1 estimation coefficient was 0.175, and the Floor4 estimation coefficient was -0.069, having reached the 1% significance level. This means that the price of Floor1 was higher than the average price for the rest of the floors by about 17.5%, while the price of Floor4 was lower than the average price for the rest of the floors by about 6.9%. The housing type estimation coefficient was 0.253, having reached the 1% significance level. This means the average building housing price was higher than the average apartment housing price by about 25.3%.

Regarding neighborhood environment attributes, the variable of distance to an MRT station estimation coefficient was $-2.604e-5$, having reached the 1% significance level. This suggests that an increase in the distance to an MRT station by 1 meter would result in a housing price reduction by about 0.026%. The distance to a railway station estimation coefficient was $-2.408e-5$, having reached the 1% significance level. This suggests that an increase in the distance to a railway station by 1 meter would result in a housing price reduction by about 0.024%. The distance to a primary school estimation coefficient was $-8.204e-5$, having reached the 1% significance level. This suggests that an increase in the distance to a primary school by 1 meter would result in a housing price reduction by about 0.082%. The distance to a junior high school estimation coefficient was $-8.360e-5$, having reached the 1% significance level. This suggests that increase in the distance to a junior high school by one 1 meter would result in a housing price reduction by about 0.083%.

Regarding difference-in-difference attributes, the estimation coefficient of the variable of when the luxury housing construction license was obtained was 0.202, having reached the 1% significance level. This means that housing prices were higher by about 20.2% after obtaining the luxury housing construction license. The estimation coefficient of the variable of luxury housing neighborhood was 0.101, having reached the 1% significance level. This suggests that housing prices in the luxury housing neighborhood were higher by 10.1%. The estimation value of the difference-in-difference was 0.106, having reached the 1% significance level. This suggests that the luxury housing (after obtaining the construction license) had positive spillover effects on neighborhood house prices by about 10.6%.

Model 3 categorizes samples in the luxury housing neighborhood (the treatment group) into three groups, including samples within the distance of 100 meters, samples between the distances of 100 meters and 300 meters, and samples between the distances of 300 meters and 500 meters, to test whether the impact of luxury housing varies with increasing distance from the luxury housing. The GLS regression results are as shown in Model 3, and its F statistic value was 765.499, having reached the 1% significance level, while \bar{R}^2 was 65.0%. The estimation results of the coefficients of variables of the basic housing properties and neighborhood environment attributes were not significantly different from those of Model 2.

Regarding the interactive items of difference-in-difference, the estimation coefficients of the samples of 100 meters, 100 meters to 300 meters and 300 meters to 500 meters after obtaining the construction license were 0.490, 0.182 and 0.047 respectively. This suggests that the spillover effects of luxury housing after obtaining the construction license will increase the housing prices in general. However, the effects will gradually decrease over greater distances from 49.0% to 18.2% to 4.7%. Moreover, the effect in the case of samples at distances from the luxury housing in the range from 300 meters to 500 meters did not reach the level of significance.

6. DISCUSSION

The focus of a DD study is $\hat{\delta}$ (interaction term coefficient). However, to make the estimation more efficient and avoid the possible selection error, covariates can be added. The covariates are selected according to the hedonic model, and the empirical results seem to be in line with prediction results.

According to the difference-in-difference attribute regression results, the time to obtain the luxury housing construction license, luxury housing neighborhood, and time to obtain the luxury housing construction license \times luxury housing neighborhood had significant and positive impacts on housing prices, as expected. The time to obtain the luxury housing construction license had a positive and significant impact on housing prices. Its estimation coefficient was about 0.202, suggesting that housing price after obtaining luxury housing construction license were increased by about 20.2%. The luxury housing had a positive impact on neighborhood housing prices. Its estimation coefficient was about 0.101, suggesting that the housing prices in the neighborhood of the luxury housing increased by 10.1%. The interactive term of the time to obtain luxury housing construction license and luxury housing neighborhood had a positive and significant impact on housing prices. The estimation coefficient was about 0.106, suggesting that the difference in the time to obtain construction license and luxury housing neighborhood and non-luxury housing neighborhood spatial difference was approximately 10.6%. The results are in line with the findings by Bourassa *et al.* (2004), Kavetsos (2012) and Ooi and Le (2013). Newly built or attractive buildings with positive effects on a neighborhood can improve that neighborhood's environmental quality and comfort to facilitate the increase in neighborhood housing prices. The luxury housing can significantly beautify the surrounding environment and maintain tidiness, so that it can help improve the neighborhood's environmental quality.

According to GLS estimation results, the difference-in-difference coefficients β_1 , β_2 , β_3 and δ were obtained. According to the descriptions of Hill *et al.* (2011) about difference-in-difference, changes in luxury housing after obtaining the construction license, luxury housing neighborhood and non-luxury housing neighborhood housing prices can be determined. Figure 1 suggests that the luxury housing neighborhood (the treatment group) housing prices will be higher than those of the non-luxury housing neighborhood (the control group). Moreover, regardless of construction decisions, there was a common trend that housing prices were increased over time. If the two increase at the same rate, after the construction decision, the neighborhood (the treatment group) housing prices will increase more rapidly than the housing prices of the non-luxury housing neighborhood (i.e., greater than the original trend). The interactive term estimated by using the difference-in-difference method $\hat{\delta}$ could be used to calculate the housing price difference before and after obtaining the construction license. To get the difference in the impact of luxury housing, we need to convert the estimation coefficient by using log-linear function type for computation to get more accurate results.

The log-linear function estimated coefficients can roughly compute and illustrate the percentage of change in a dependent variable caused by each unit of independent variable. The method is fast and easy. To more accurately illustrate the regression coefficients estimated by using the log-linear function, the regression coefficients can be

input into $100(e^{\hat{\delta}} - 1)\%$. By multiplying the value and the average housing price of the sample data, this paper computed the real change in housing prices caused by each unit of change in an independent variable. The computation of the log-linear function is as shown in Table 4. The intercept, *TIME*, *TREAT*, *TIME*×*TREAT* GLS estimated coefficients were $\hat{\beta}_1 = 6.134$, $\hat{\beta}_2 = 0.202$, $\hat{\beta}_3 = 0.101$ and $\hat{\delta} = 0.106$, respectively. By multiplying the results of $100(e^{\hat{\delta}} - 1)\%$ with the average sample housing price, we obtained 460.3, 312.7, 148.5 and 156.2, respectively. This suggests that the intercept is the starting price without the influence of any other variables. The basic housing price is about 4.603 million NTD. In the case of the control group, after obtaining the construction license, the housing prices increased by 3.127 million NTD. Housing prices in the neighborhood of the luxury housing before obtaining the construction license were higher by about 1.485 million NTD. The difference before and after getting the construction license and the luxury housing neighborhood and non-luxury housing neighborhood difference, that is, the difference-in-difference housing price, was about 1.562 million NTD.

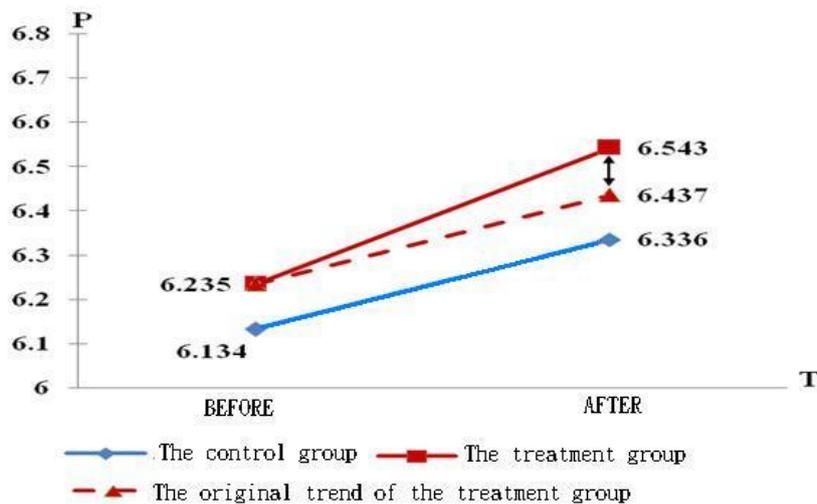


Figure-1. difference-in-difference estimation results

Table-4. Log-liner function conversion

Conversion equation:	$100(e^{\hat{\delta}} - 1)\%$			
	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\delta}$
M500	6.134 (460.3)	22.4% (312.7)	10.6% (148.5)	11.2% (156.2)

Note: the value in the brackets refers to the price of converted result percentage multiplied by sample average housing price measured by the unit of NTD (10,000).

7. CONCLUSION AND SUGGESTIONS

7.1. Conclusion

This study applied the difference-in-difference method by the time to obtain luxury housing constructio

Kiel and McClain (1995), Dehring *et al.* (2007) and Ooi and Le (2013), Bourassa *et al.* (2004) argued that attractive buildings can increase neighborhood housing prices. However, empirically, they only estimated the impact of buildings on neighborhood housing prices without deducting the location difference caused by time trends and geographic space from the estimation results, and thus may have overestimated the impact of such buildings. The difference-in-difference method applied in this study can explore the impacts of differences caused by the

occurrence of an event and by geographic space on housing prices. Through the interactive variables of time and space -- that is, the interactive term of the time to obtain the luxury housing construction license and luxury housing neighborhood -- this study was able to provide more accurate estimation results.

According to the empirical results of this study, the housing price difference caused by the time to obtain the construction license and distance to the luxury housing was about 1.56 million NTD, suggesting that obtaining a construction license has a real impact on luxury housing neighborhood housing prices. That is, the average housing price increases by about 1.56 million NTD after obtaining a construction license. This paper further categorized the treatment group samples into those within 100 meters, those between 100 meters and 300 meters and those between 300 meters and 500 meters for estimation. The results suggested that housing prices increase in inverse proportion to the distance from the luxury housing neighborhood.

7.2. Research Limitations and Follow-Up Suggestions

Due to the limitation of data processing, this study only measured the nearest linear distance of a given house from the relevant public facilities without considering the real geographical environment (e.g., rivers and slopes) and urban road planning. If the real distances from the houses to the public facilities can be measured and the above geographic environment and urban roads can be considered in a follow-up study, then housing prices can be more accurately and realistically estimated.

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