Empirical Study of the Impact of Taoyuan Airport Metro on Nearby Housing Price

Hsin-Yu, Chen Yi-Ting, Peng

Abstract

This paper collected property data from March in 2016 to March in 2018. By using Ordinary Least-Square Method and Difference in Difference estimation to analyze the impact on nearby residential housing price by the operation of Taiwan Taoyuan international airport metro. Through empirical analysis, the housing price have indeed increased after metro operation. Before operation of the new metro, average housing price in districts, where metro system have existed, are 102,790 NTD higher than districts, where metro system have not existed. However, after operation of the new metro, housing price in districts, where metro system have not existed, increased more dramatically than those with metro system previously, which the housing price difference between them have shrinked.

1 Introduction

Taiwan Taoyuan international airport metro has been operating for one year since March in 2017. It has taken 20 years to prepare for the formal operation. Originally, Taiwan Taoyuan international airport metro was designed to solve the frequent traffic jam on Sun Yat-sen Freeway, and also be an alternative transportation to the airport. Construction of the metro could not only improve the accessibility of nearby districts, and also create more business opportunities to shops along the metro line. Moreover, as an additional transportation choice, the new metro brought more stable and convenient commuting experience to either citizens or foreign travellers.

However, the traffic infrastructure would influence nearby districts in multiple aspects, such as residential living environment, land classification, noise control, and housing price. Since the housing price are closely related to people's property value, changes of housing price have always been the focus of people's attention. Construction of the metro have promoted the economic growth of nearby areas, but also cause the fluctuation in housing price.

From constructing to operating, some people claimed the housing price has increased, and some people suggested the opposite. With the improvement of transportation and convenience, some expected the housing price to increase. On the other hand, some did not think so because of the current economic distress and the correction period of housing market.

This paper studies changes of housing price between one year before (March in 2016 to February in 2017) and after (March in 2017 to March in 2018) the new metro

operation. This study regards housing where located along the 18 metro stations within distance of 1000 meters as sample data, and conducts analysis about the impact on prices caused by the metro operation. Furthermore, this study also compares influence in housing price in districts, where metro systems have already existed before the new metro, with districts on the opposite condition.

2 Literature Review

Since convenience is one of the most influential factors to housing price, the new metro can enhance the the accessibility and economic growth of nearby districts; thus, it is generally said that constructing metro system can bring positive effect to nearby areas. For example, Jen-Jia Li and Chi-Hau Hwang (2003) built regression models to study changes in housing price along Danshui Line, which clearly showcased the operation of metro could increase housing prices. Cheng Min Feng, Pin Yi Tseng and Gueen Feei Wang (1994) derived price difference in urban, suburb and outskirts from analyzing Wenhu Line, Xindian Line, Bannan Line and Danshui Line's housing data. From foreign research papers, Hui Sun, Yuning Wang and Qingbo Li (2016) built Hedonic price regressions to estimate the impact posed by Tientsin Metro on housing price within 1 kilometer. Voith (1991) analyzed property data and transportation system data in 1980 and discovered housing prices in Philadelphia increased 5,147 dollars after constructing metro system. Bajic (1983) established Modal choice model and Hedonic price regressions to compare Tornoto districts' price in 1971 and 1978, and found out the price increased 2,237 dollars because of enhancing the accessibility in those regions. However, some people provided different results. Debrezion, G., Pels, E., and Rietveld, P. (2007) found that the effect of railway stations on commercial property value mainly takes place at short distances.Moreover, commuter railway stations have a consistently higher positive impact on the property value compared to light and heavy railway stations. That is to say, they claimed that other accessibility variables, such as highways, in the models reduces the level of reported railway station impact. Gatzlaff and Smith (1993) examined the impact of the development of the Miami Metrorail system on residential property values proximate to its station locations from 1971 to 1990. From comparing Repeat-Sales Indices and applying Hedonic regression methods, they claimed the residential values were, at most, only weakly impacted by the announcement of the new rail system.

Besides discussing the degree of transportation effect on housing price, whether different houses' location would be an important factor affecting appreciation also is a great issue. Der Yang Hong and Chu Chia Lin (1999) applied real transaction records to estimate the actual impact of subway system and road width on the housing price at Taipei city in 1991. They found that subway system does have a significant impact on housing prices and the size of impact decreased with the distance to the subway station increased. Similarly, Cheng Min Feng, Pin Yi Tseng and Gueen Feei Wang (1994) discovered the size of impact was negatively related to the distance to the subway station

by analyzing Wenhu Line, Xindian Line, Bannan Line and Danshui Line's housing data. Daniel P.McMillen, and John McDonald (2004) examined the effect of the new rapid transit line from downtown Chicago to Midway Airport on single-family house prices before and after the opening of the line. The results showed that the difference between the increase in the value of homes within the sample area as compared with properties farther away from the new transit stations was approximately 216 million dollars between 1986 and 1999. In addition, Benjamin and Sirmans (1996) discovered distance from a metro station had an adverse impact on apartment rent. To elaborate, each one-tenth mile increase in distance from the station results in a decrease in rent per apartment unit of about 2.50%. Damm, D., Lerman, S. R., Lerner-Lam, E., and Young, J.(1980) examined real estate values before and after construction of a transit system in Washington, D.C. and found as the distance between a metro station and an estate increased, the value would decrease. Also, retail estate values were affected more in comparison of residential estate values in their study results.

A review of the domestic and international research reveals that metro system indeed would influence housing price, and scholars have primarily been studying the degree of influence on the appreciation of the value of nearby properties which has been caused by the construction of rail transit in various cities from an empirical point of view. From several research papers, we can see that traffic improvement is an important factor affecting land appreciation. Furthermore, the housing price increased as the distance to the subway station decreased. Although we can see specific values of estimation in foreign research, there are limitation of sufficient data in domestic research to get exact approximation numbers.

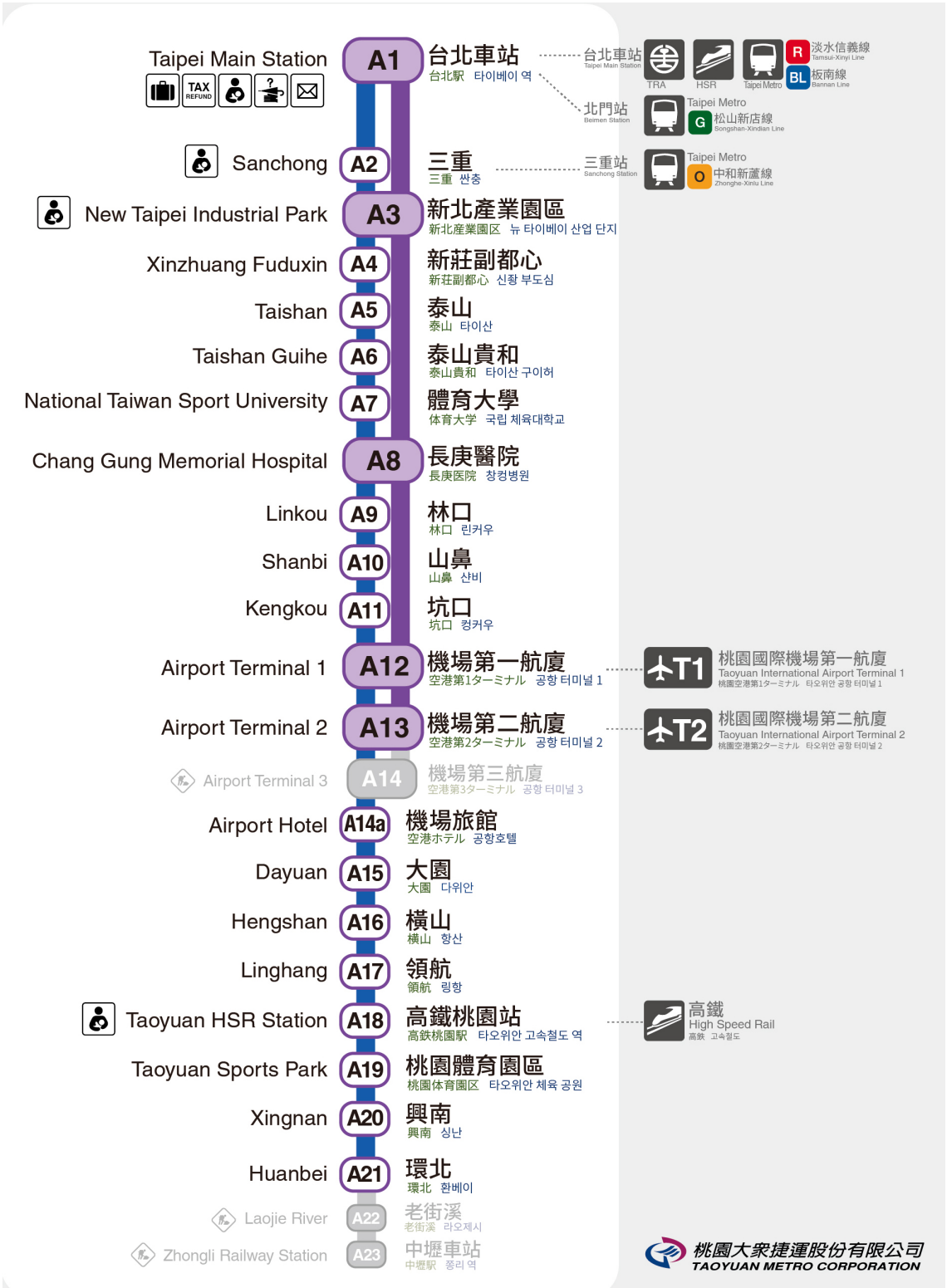
3 Research Methodology

3.1 Data Sources

For data collection, all of the housing price data were collected from the actual transaction data listed on the "Property Transaction Open Data Website of Ministry of the Interior" and "Registration of the Actual Selling Real Estate Price" on Sinyi Realty Website. Data of transaction date, location, housing ages, room numbers, floor, plain, price per plain and total estate values, were all included. Selected property data that were 1000 meters distance to the station along Taoyuan international airport metro, ranging from A1 Taipei Main Station to A21 Huanbei Station, and time period started in March, 2016 to March, 2018, as datasets with 12,923 valiable samples.

Through the National Land Use Zoning Information System on the Ministry of the Interior Website, the land use utilization status of samples were divided into commercial areas and non-commercial areas. Moreover, both the regional and municipal population density were calculated by data obtained from the Statistical Information Network Website, which the population of the region and the city were divided by total area.

Figure 1. Route Map of Taoyuan International Airport Metro



3.2 Selection of Variables for the Model

Dependent variables in the model are housing price per plain in ten thousands dollars and housing price per plain in natural logarithm. Independent variables are showed in the below Table 1.

Among the collected samples, 59.60% of samples' housing ages are less than 5 years; 23% of samples' housing ages fall between 10 and 30 years. In addition, 47.65% of samples are located in Taoyuan City; 45.18% are located in New Taipei City and 7.17% are located in Taipei. It is worth noting that housing ages which are less than 5 years mostly lie in Taoyuan; old houses are mostly situated in Taipei, which 83.19% of samples' house ages bigger than 50 years are in Taipei.

Among the collected samples, Taipei Main Station, Sanchong Station, and Taishan Guihe Station are stations that there are other metro existed within 500 meters distance besides the new international airport metro and these data stand up for 22.74% of total samples. Houses with transaction date before the new metro operation take up 60.65% and 39.35% of transaction samples are after the operation. Furthermore, selected data are divided into two groups, distance to station within 700 meters and more than 700 meters, 44.07% of samples' distance between the house and the station are less than 700 meters.

Table 1. Description of Variables for Modelling

Independent Variable	Description	Expected Estimation
age	housing age	-
commercial	located in commercial area=1	+,-
city_long	time of becoming a special municipality	+
city_dpop	population density of the city	+,-
dis_pop	population density of the district	+,-
mrt	other metro existed nearby within 500m=1	+
operation	date after the new metro operation=1	+
mrtd	distance between new metro and existed metro	-
mrt_op	multiple of mrt and operation	-
d_700	distance to station within 700m=1	+
d_op	multiple of d_700 and operation	+

3.3 Descriptive Statistics of Variables

Descriptive statistics of variables in the model are showed below Table 2.

Table 2. Summary Statistics for Variables in the Model

Variable	Mean	Std Dev.	Maximum	Minimum
perprice	31.00	19.59	0	469.3
lgperprice	12.51	0.51	15.36158	7.600903
age	8.70	11.80	107.3	0
commercial	0.33	0.47	1	0
city_long	9.18	11.78	51	4
city_dpop	2428.81	2075.25	9917.969	1759.092
dis_pop	7966.48	7371.457	23792.3	988.63
mrt	0.23	0.42	1	0
operation	0.39	0.49	1	0
mrtd	71.43	146.64	500	0
mrt_op	0.11	0.32	1	0

4 Model Construction and Empirical Analysis

4.1 Model Building

To estimate the impact of the new airport metro, the Ordinary Least-Square Method and Difference in Difference Method are mainly used in this study. Regarded the new airport metro as the target variable, regions where metro systems have existed prior to the new metro were taken as experimental groups, and regions on the contrary as control groups. Since the past literature mostly used the Hedonic Price Medol, and considering that the house prices are more appropriate in terms of percentage change, the dependent variables in the regression are housing prices per plain or prices per plain in terms of natural logarithm. On the other hand, independent variables are factors that would possibly influence the housing prices, such as housing ages, land use zoning, population density of the city, and also considering that the length of time when a place becomes a municipality has an impact on the the urban function of the area, which may affect the house price, so it is especially added to the regression.

After using the OLS (Ordinary Least-Square) method for the first time to linearly estimate the regression, it was found that the housing price where the metro system has already existed was lower before the operation. It was speculated that there were omitted variables which caused this bias. This problem has been fixed after joining a new variable, the distance between the airport metro station and the original metro station.

From Figure 3, it can be seen that the minimum housing prices are rising after the operation. From the observation in Figure 4, it can be found that the data is classified as the existence of other metro systems previously, and the monthly average price per plain of all the data is calculated. In each year, from 2016 to 2018 years, the monthly average housing prices in the region with other metro systems are higher than

that where other metro systems did not existed. Furthermore, the connected 12-month trend is located above the average monthly rate in those places where there is no other metro system existed before.

Figure 2. Regression Models

$$\text{perprice} = \beta_0 + \beta_1 age + \beta_2 \text{commercial} + \beta_3 citylong + \beta_4 dispop + \beta_5 mrt + \beta_6 operation + \beta_7 mrtd + \beta_8 mrtop$$

$$\text{lgperprice} = \beta_0 + \beta_1 age + \beta_2 \text{commercial} + \beta_3 citylong + \beta_4 dispop + \beta_5 mrt + \beta_6 operation + \beta_7 mrtd + \beta_8 mrtop$$

Figure 3. Minimum Housing Price Trend

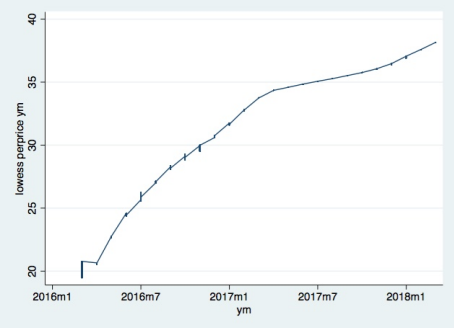
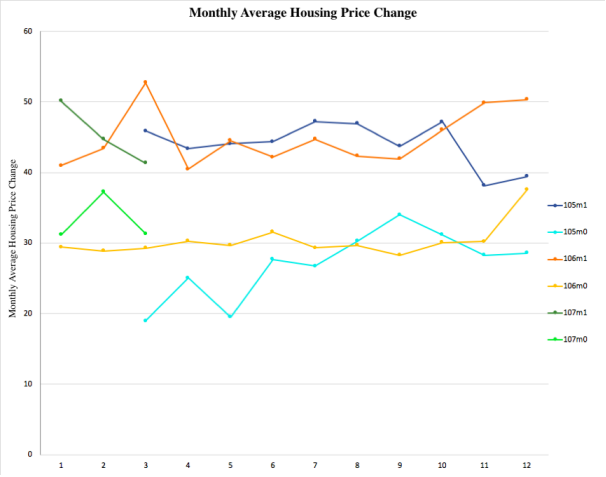


Figure 4. Monthly Average Housing Price Change



4.2 Analysis Results

The main estimated results of this study are listed in Table 3. Among them, the result is the difference between the population density of the local area or the municipality, and

the result of the population density of the local area as independent variable is listed in columns (1), (2) and (3); the population density of the municipality as independent variable is listed in columns (4), (5) and (6). And dependent variables respectively are the housing price per plain and the price in natural logarithm.

First, this study compared the basic feature variable results in columns (1) and (2). The results of column (1): When controlling other variables, as the house age increases by one year, the price per plain will be reduced by an average of 2,420 NTD. When other variables are controlled, if the residential house is located in a commercial area, the average price will be reduced by 41,870 NTD per plain. If the municipality to which the house belongs is established for more than one year, the price per plain will increase by more than 8,000 NTD. After joining main dependent variables, we can find that the changes in the house age and the municipality are not obvious. Also, whether the residential effect in the commercial district was originally overestimated by about 3,490 NTD on average. This result is consistent with research done by Chien-Wen Peng and Chung-Hsien Yang (2009), if the real estate in the city center is located in the commercial area, the housing price would be reduced by 925,000 NTD.

Furthermore, in addition to the basic features mentioned above, in the coefficient of column (2), we feel that the positive or negative of multiple coefficients is not reasonable. For example, if other variables are controlled, except the new airport metro, the area with other metro stations were lower than that with no other metro systems by the average of 78,000 NTD. However, our speculation is that because the local accessibility of other metro stations is better, the price per plain should be higher than the price of the house without other metro stations nearby. Another unreasonable point is that when the distance between the two metro stations is farther, it will become less convenient, which causes the housing price to fall; but in the result of column (2), it is positive, although its estimation value is not large. Compared with column (5) in Table 3, the statics significance of the latter is also higher than that of the former. We think that the coefficient of the column (5) and the value are more in line with the actual situation, and more reasonable.

From the results in column (5), when the other variables are controlled, average price per plain of variables with other metro systems existed nearby, compared with the others, will be 100,790 NTD higher. After the operation, the price per plain of those with other metro systems existed nearby will increase by 2,470 NTD; housing prices of districts with no other metro stations will increase by 28,170 NTD, whixh the latter's increase is larger than the former.

In the column (6), the housing price per plain in the form of natural logarithm is taken as the dependent variable, and the result of the coefficient can be interpreted as the change of proportion and degree. When others remain unchanged, as the house age increases by one year, the housing price will fall by 0.7 percentage points. when controlling the other factors, the housing price per plain in the commercial district will drop by 5.2 percentage points. When the city becomes a municipality for more than one year, it will make it to increase 18.8 percentage. When other factors remain unchanged, the housing price of other metro systems existed nearby is 30% higher than

that without other metro systems nearby. After the airport metro operation, the price per plain is 10.5 percentage points higher. The actual operational effect between the two will make the original metro station less effective, and the housing price without other metro systems nearby previously will increase more.

It can be found that if there are other line metro stations near the original airport metro station, it will be higher than the price of the area without other metro stations nearby. After the operation of the new airport metro line, local accessibility increased, which led to an increase in housing prices. Among them, areas with a large degree of change in accessibility, housing prices rose more, making the price of the area without other metro stations nearby more consistent with those with other metro systems. From the Difference-in-Difference table in Table 4. The following table is written as a percentage of the value that has changed, and other control factors are omitted. In the gap between the operation of the metro and the gap between the operation and the local operation without the metro, the impact of 8.03% on the housing price was reduced.

In Table 5, the variable of the house within 700 meters from the Airport metro line is added, and its multiple with operation is added. In the column (2) of Table 5, when other control factors remain unchanged, the house within 700 meters will increase by 0.7 percentage points; whether within or over 700 meters, the housing price will rise 9.6 percentage points after the operation, and distance within 700 meters, housing price will increase of 7.5 percentage points additionally.

In the model of Table 5, results of the variable density of the population in the area is more reasonable than the variables in the municipality. Since the variables are more localized, which we should pull the variables down one level, and the variable coefficient of the distance of 700 meters in the column (4) is not reasonable; thus, it is believed that the regression results in column (2) are more in line with expectations.

When the house is less than 700 meters away from the airport metro station, the housing price will be higher than the price of 700 meters away from the metro station. After the operation, the commute convenience will be implemented due to the distance, and both Prices are rising. However, as the distances are closer, the convenience of the MRT will be more obvious, so the increase will be even higher.

Table 3. Regression Table

	perprice(1)	perprice(2)	lgperprice(3)	perprice(4)	perprice(5)	lgperprice(6)
age	-0.242 (19.12)***	-0.241 (19.09)***	-0.007 (19.23)***	-0.218 (18.93)***	-0.248 (20.65)***	-0.007 (21.74)***
commercial	-4.187 (14.52)***	-3.489 (11.93)***	-0.187 (23.61)***	-0.742 (2.52)**	-0.061 (0.21)	-0.052 (6.85)***
city_long	0.809 (55.52)***	0.845 (55.34)***	0.021 (51.15)***	5.057 (55.96)***	5.047 (52.27)***	0.188 (75.46)***
dis_dpop	0.001 (29.13)***	0.001 (26.57)***	0.000 (40.98)***			
mrt		-7.418 (6.35)***	-0.447 (14.10)***		10.279 (12.26)***	0.300 (13.82)***
operation		3.688 (12.08)***	0.137 (16.52)***		2.817 (9.63)***	0.105 (13.87)***
mrtd		0.006 (2.53)**	0.001 (11.15)***		-0.030 (15.71)***	-0.001 (16.15)***
mrt_op		-1.480 (2.44)**	-0.106 (6.45)***		-0.770 (1.33)	-0.080 (5.36)***
city_dpop				-0.023 (45.44)***	-0.024 (43.92)***	-0.001 (67.60)***
_cons	21.712 (105.61)***	19.345 (76.88)***	12.155 (1780.73)***	43.359 (96.11)***	42.968 (85.57)***	13.102 (1008.74)***
R^2	0.36	0.38	0.42	0.42	0.43	0.52
N	12,772	12,772	12,768	12,772	12,772	12,768

*p<0.1 ; **p<0.05 ; ***p<0.01

Table 4. Difference-in-Difference Table

	Other Metro Existed	No Other Metro	
Before Operation	13.10+0.30	13.10	0.30
After Operation	13.10+0.30+0.10-0.08	13.10+0.10	0.22
	0.02	0.10	-0.08

Table 5. Regression Table

	perprice(1)	lgperprice(2)	perprice(3)	lgperprice(4)
age	-0.251 (19.84)***	-0.007 (20.26)***	-0.226 (19.57)***	-0.006 (20.64)***
commercial	0.801 (11.02)***	0.019 (21.90)***	4.926 (0.74)	0.186 (4.36)***
city_long	0.801 (54.39)***	0.019 (47.04)***	4.926 (53.50)***	0.186 (78.25)***
dis_dpop	0.001 (27.75)***	0.000 (39.90)***		
d_700	0.180 (0.51)	0.007 (0.74)	-1.511 (4.42)***	-0.062 (7.04)***
operation	2.654 (7.86)***	0.096 (10.42)***	1.174 (3.59)***	0.036 (4.21)***
d_op	2.330 (4.42)***	0.075 (5.18)***	3.366 (6.64)***	0.116 (8.88)***
city_dpop			-0.023 (43.35)***	-0.001 (68.09)***
_cons	20.403 (80.08)***	12.215 (1751.21)***	42.445 (82.72)***	13.108 (987.61)***
R^2	0.38	0.41	0.42	0.51
N	12,772	12,768	12,772	12,768

*p<0.1 ; **p<0.05 ; ***p<0.01

5 Conclusion

From the regression results, housing prices, where other metro systems have already existed before the new airport metro, are much higher than prices of houses with no other metro systems. After the operation of the new metro, the housing price increased as the accessibility enhanced. Moreover, housing prices in districts with apparent change in accessibility increased more and appeared more consistent with housing prices with other metro systems previously. In addition, after the operation of the new airport metro, people have more choices to available public transportation, and the accessibility of areas were improved, which have made lives more convenient. Therefore, the housing prices were significantly higher than that before the operation. This result is consistent with past literature results.

According to problems encountered in the process of this research, here puts forward the following suggestions for the follow-up research direction. Since this paper's research time mainly focuses on one year before and after the airport metro operation, which two years of real estate transaction data were selected. Although this excluded the impact on housing prices from the long-term overall economy, it did not take into account that the impact on housing price had already existed during the construction of the new airport metro. That is to day, when people notice that there will be new traffic infrastructure, it is generally expected that the housing price in the area will rise. However, in this paper, we are not sure whether the increase in housing prices have been changed during the construction period or after the operation. Hence, if we can collect more long-term and large-scale housing research in terms of the planning, construction, operation and other different times of the new airport metro, and also compare the changes in housing prices at different stages.

Furthermore, limited to data on "Property Transaction Open Data Website of Ministry of the Interior" and "Registration of the Actual Selling Real Estate Price" on Sinyi Realty Website, and this study did not consider pure land and pure parking spaces such real estate transactions; thus, three stations were excluded because of lacking data, such as Airport Terminal 2 Station, Hengshan Station and Xingnan Station. If the housing transaction data are more complete, the regression results may be more accurate and more closer to real life.

Last but not least, in this study, sample data were divided divided into two groups, distance to station within 700 meters and 1000 meters. Although the estimated impact on housing price between this two groups is roughly the same as the previous research, the real estate price decreases as the distance to the station increases. However, the difference in estimated impact between two groups is statistically insignificant in this study. It is probably because the two classification distance indicators adopted in this study are too close, which the difference between 700 meters and 1000 meters is small. If future research can make a more detailed classification of distances or set a larger difference between the two, the impact quantity probably would be more clearly reflected in the results. For example, Cheng Min Feng, Pin Yi Tseng and Gueen Feei Wang (1994) divided the real estate data into three groups, distance to station ranged

from 0 to 100 meters, 100 to 300 meters and 300 to 500 meters, which can easily compare the influence on housing prices in terms of these three groups.

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