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The effects of mass rapid transit station on the house prices in Taipei: the hierarchical linear model of individual growth

Fen-may Liou[a], Shih-Yu Yang[a], Borliang Chen[b] and Wan-Ping Hsieh[c]

[a]Department of Finance, Chihlee University of Technology, New Taipei City, Taiwan; [b]Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan, ROC; [c]Institute of Business Management, National Chiao Tung University, Taipei City, Taiwan

ABSTRACT

A number of studies have examined the impact of mass rapid transit (MRT) systems, especially the transit station, on house prices, and the conclusions vary. While most studies focused on the analysis at an aggregate level, this paper develops a hierarchical hedonic price model of individual growth to investigate the effects of real estate's proximity to the train stations, together with other house/neighborhood-specific characteristics, on the longitudinal growth pattern of house prices in Great Taipei. Sample houses are those located within a radius of one kilometer from selected MRT stations. The empirical results show that: (1) the growth pattern of housing price in real terms over time is significantly upward; (2) the city in which the house is located and the type of building positively moderate such growth trajectory; and (3) the influences of both the distance to MRT on house prices and on the growth pattern of house prices are insignificant. Discussion and implications of these findings were provided.

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House price; hedonic price model; hierarchical linear model of individual growth; mass rapid transit station; Taipei

Introduction

Mass rapid transit (MRT) systems are one of the most important attributes of house prices in metropolitan areas that catch the attention of real estate investors, academia, and policy-makers (Andersson, Shyr, & Fu, 2010; Chatman, Tulach, & Kim, 2012; Kim & Lahr, 2014). The first MRT line with 24 transit stations started operation in Taipei City in 1996. In May 2015, there were 7 lines with 108 stations in total, covering most administrative districts in Taipei City and the major districts in New Taipei City. During 1998–2015, Sinyi Housing Price Index, the credible house price index provided by Sinyi Research Center for Real Estate (managed by College of Commerce, National Chengchi University in Taiwan), for Taipei Metropolitan experienced a downward trend from the first quarter of 1998 to the second quarter of 2003 due to the negative impact of the Asian Financial Crisis in 1998 (Chang & Wu, 2002). It followed a price boom thereafter, and reached a peak in the second quarter of 2014 before turning to drop.

CONTACT Fen-may Liou mayliou@mail.chihlee.edu.tw

The hedonic price method, which is initialed by Rosen (1974), is the most common model used to examine the determinants of house prices and to forecast house prices. Different from the conventional hedonic house price model or the spatial panel model that were linear regression, the hierarchical viewpoint indicates that households usually take a hierarchical decision-making process and suggests using a hierarchical linear model (HLM) to account for the inherent hierarchy in determining housing prices (Brown & Uyar, 2004). However, this HLM house price model does not predict the long-term path of house prices. Kim and Lahr (2014) used repeat-sales data of properties that sold at least twice to investigate how relative accessibility gains across stations and anticipation of the commencement date of the HBLR station influence home price change. Their models did not examine the effects of house/neighborhood – specific characteristics on the initial stage of house prices and the price change pattern.

This paper proposes a two-level hedonic price model in which the effects of the time-varying variables (covariates at level 1) on the growth pattern of individual house prices are random and determined by neighborhood-specific and house-specific characteristics (covariates at level 2). Our goal is to examine the effects of house-specific and neighborhood-specific features, including MRT station proximity on the long-term change pattern of house prices. The validity of using HLM of individual growth to serve this goal is twofold. First, HLM can be used to explain outcomes for members of groups by estimating linear equations as a function of the characteristics of the groups and the characteristics of the members (Arnold, 1992). Second, while HLM estimates are based on repeated measures (or longitudinal data), the repeat sales method has been demonstrated as the most accurate estimate of house price appreciation among several parametric and non-parametric methods; its accuracy is least diminished by a reduction in sample size (Crone & Voith, 1992).

Literature review

The effects of mass transit stations on house prices

A number of studies have tested the effects of proximity to MRT stations on residential property value, and the conclusions vary. The positive results suggested that the price increase of the houses proximate to the new transit station was higher than those farther away from the new transit station (Grass, 1992). In addition, Efthymiou and Antoniou (2013) indicated that proximity to transportation infrastructure has a direct impact on house and apartment purchase prices and rent rates for metro, train, and suburban railway systems. The housing prices near MRT stations higher than elsewhere are due to convenient access to daily life venues, such as place of employment, shopping, and schools (e.g. Bowes & Ihlanfeldt, 2001; Chatman, Tulach, & Kim, 2012; Debrezion, Pels, & Rietveld, 2007; Hess & Almeida, 2007; Lewis-Workman & Brod, 1997) or reduce transportation cost (Bajic, 1983). The positive effects were shown especially in years when the MRT system was at its planning stage (McMillen & McDonald, 2004) or when it started operation (Wang, 2010) and were stronger when the station proximity was coupled with a pedestrian-oriented environment (Duncan, 2011). In general, price of the houses located closer to transit stations were higher if MRT systems were built associated with some kind of regional development projects (Cervero & Murakami, 2009; Mathur & Ferrell, 2013).

Other studies indicated a significant price-dumping effect of MRT proximity, due to noise pollution and unattractive views (e.g. Gatzlaff & Smith, 1993; Martínez & Viegas, 2009). Pan (2013) indicated that while opening of the light rail in Houston had significant net positive effects on some residential property values, immediate proximity to transit stations has significant negative impacts on properties located within a quarter mile of the transit station. Similarly, Geng, Bao, and Liang (2015) found that although high-speed rail stations had positive effects on house prices within .891–11.704 km, they had negative effects within .475–.891 km.

In contrast to the findings mentioned above, Portnov, Genkin, and Barzilay (2009) and Mohammad, Graham, Melo, and Anderson (2013) found no significant effect of train station proximity on residential property values. Similarly, Andersson et al. (2010) explored that station proximity of the high-speed railway line in southern Taiwan has at most a minor effect on house prices. Furthermore, Shyr, Andersson, Wang, Huang, and Liu (2013), who examined the transit system and the property value in Hong Kong, Taipei, and Kaohsiung, also found that increases in the spatial coverage of transit systems reduces the intraregional variability in overall transit accessibility.

Other attributes of house prices

A number of attributes of house prices, including house-specific and neighborhood-specific characteristics as well as macroeconomic variables have been investigated in prior literature. The house-specific variables available in the database were included in the HLM hedonic pricing model. They are: house-specific characteristics, which are the age, size, and the type of building; spatial attributes such as land use regulation (Ihlanfeldt, 2007); and socioeconomic variables, which are population density, education level, and per capita income.

The diversified conclusions in previous studies on the effects of MRT stations on house prices signify that the magnitude of the effects of transit station accessibility on house prices may depend on the structure of the city (Debrezion, Pels, & Rietveld, 2011). The findings of these studies provide useful information for real estate investors about the relationships between MRT stations and other hedonic characteristics with house prices. However, they did not assess how these house-specific attributes affect the growth of house prices at the individual level. Our study provides a useful approach to test the effects of MRT stations and other attritions on the change patterns of house prices at the individual level in Taipei. It provides useful information to the real estate investors who usually seek profits from price changes of individual houses. The decision to buy a house is usually based upon vague expectations for the future (Shiller, 2007). MRT station proximity is the most important characteristic in for-sale advertisements promoted by real estate companies and brokers in Taiwan. People believe that the value of houses near MRT stations will become very valuable in the future, and that may drive the prices up. Therefore, we propose that house prices are negatively related to the distance from the house to the MRT station. However, the effect of the distance from MRT on the individual house price is decreasing over time while the MRT network coverage is expanding.

Methodology

HLM of individual growth incorporates random effects like panel data models and random coefficients. That is, the intercepts and the coefficients of the time-covariates at the first level are determined by the time-invariant variables at the second or more subsequent levels. The analysis of HLM of individual growth model focuses not only on the change pattern of individuals including the average level but also on the acceleration of that pattern in which the dependent variable changes with time (Snijders, 1996, p. 282).

Urban economics link appreciation of house prices with urban growth (Capozza & Helsley, 1989). A number of economic models have developed to examine the determinants of house prices including income level (Gallin, 2002) and demographic characteristics such as population density (Acharya & Bennett, 2001), level of education (Macpherson & Sirmans, 2001), land use regulations (Ihlanfeldt, 2007), size (Tabuchi, 1996), and the location city (Gyourko, Mye, & Sinai, 2006). These variables were incorporated into our individual growth model of house prices.

In the empirical study, we first carried out the conventional cross-sectional regression and the first-order autoregressive model to examine the possible determinants of house prices in Taipei. A one-way analysis of variance was subsequently taken to confirm that the variability in the house prices is significantly different than zero. An unconstrained null model was subsequently used to test if there were any differences at the group level on the house prices, and justified the utilization of hierarchical model. We then developed an HLM of individual growth to analyze the patterns of price change of heterogeneous residential houses over time. As shown in Equation (1), time is used as a Level-1 covariate to examine change over time together with three time-varying covariates. The time-invariant characteristics of the house and neighborhood attributes are at Level 2 as shown in Equation (2).

Level 1

$$\text{Price}_{it} = \pi_{0i} + \pi_{1i}(\text{Time})_{it} + \xi_i(\text{Income})_t + \xi_2(\text{Edu})_t + \xi_3\left(\text{Density}\right)_t + \varepsilon_{it} \quad (1)$$

Level 2

$$\begin{aligned}\pi_{0i} &= \gamma_{00} + \gamma_{01}\text{Distance}_i + \gamma_{02}\text{City}_i + \gamma_{03}\text{Age}_i + \gamma_{04}\text{Size}_i + \gamma_{05}\text{Type}_i + \gamma_{06}\text{Width}_i + \gamma_{07}\text{Zoning}_i + \mu_{0i}\\ \pi_{1i} &= \gamma_{10} + \gamma_{11}\text{Distance}_i + \gamma_{12}\text{City}_i + \gamma_{13}\text{Age}_i + \gamma_{14}\text{Size}_i + \gamma_{15}\text{Type}_i + \gamma_{16}\text{Width}_i + \gamma_{17}\text{Zoning}_i + \mu_{1i}\end{aligned} \quad (2)$$

Combining Equations (1) and (2), we receive the mix model as Equation (3):

$$\begin{aligned}\text{Price}_{it} = &(\gamma_{00} + \gamma_{01}\text{Distance}_i + \gamma_{02}\text{City}_i + \gamma_{03}\text{Age}_i + \gamma_{04}\text{Size}_i + \gamma_{05}\text{Type}_i + \gamma_{06}\text{Width}_i + \gamma_{07}\text{Zoning})\\ &+ (\gamma_{10} + \gamma_{11}\text{Distance}_i + \gamma_{12}\text{City}_i + \gamma_{13}\text{Age}_i + \gamma_{14}\text{Size}_i + \gamma_{15}\text{Type}_i + \gamma_{16}\text{Width}_i + \gamma_{17}\text{Zoning})\\ &\times (\text{Time})_{it} + \xi_{1i}(\text{income})_t + \xi_{2i}(\text{Edu})_t + \xi_{3i}(\text{Density})_t + \mu_{0i} + \mu_{1i}(\text{Time})_{it} + \varepsilon_{it}\end{aligned} \quad (3)$$

whereas, Price_{it} is the price of residential house i at time (year) t; Time_{it}, denoting the transaction year t of house i; *Distance* denotes the distance from the house to the MRT station; Age_i, Size_i, Type_i, and Zoing_i are the house i's characteristics and neighborhood feature, which are size transferred in the transaction, the type of building, and land use zoning. Income_t, Education_i, and Density_i denoting per capital income, average education level, and population density in the area where the house is located, are time-variant socioeconomic attributes.

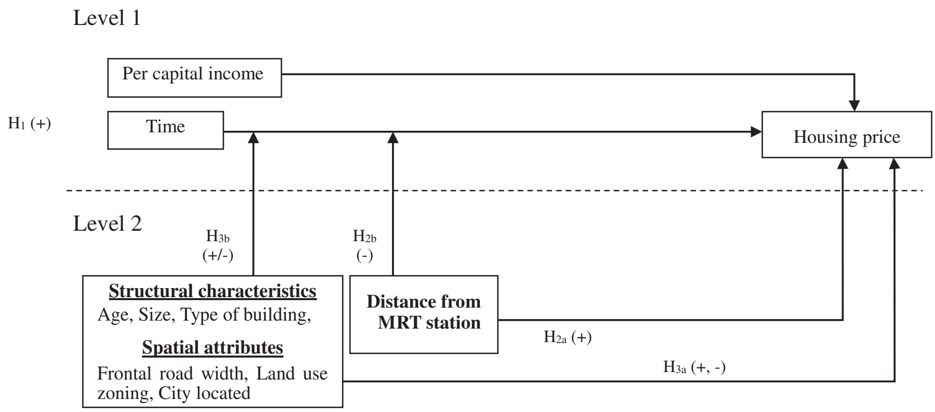

Figure 1. Hedonic house pricing model with HLM of individual growth. Source: Authors.

The residual errors $\varepsilon_{it} \sim N(0, \sigma^2)$ at Level 1 follow a first-order autoregressive process (AR(1)) while the error terms at Level 2 are:

$$\begin{bmatrix} \mu_{0i} \\ \mu_{1i} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \tau_{00} & \tau_{10} \\ \tau_{10} & \tau_{11} \end{bmatrix}\right) \tag{4}$$

whereas, τ_{10} is the unstructured covariance of $\begin{bmatrix} \mu_{0i} \\ \mu_{1i} \end{bmatrix}$.

The research model of the hedonic house price model with the HLM of individual growth is shown as Figure 1.

Data

Data were collected from the database, Real Estate Transaction Price Inquiry System, managed and provided by the Department of Land Administration, Ministry of the Interior, from the first quarter of 2004 to the second quarter of 2012, when the database was disrupted and switched from self-assessment to actual transaction price system thereafter. Sample houses are those located within a radius of a kilometer form 10 selected MRT stations (one in New Taipei City and nine in Taipei City) covering nine administrative districts (one in New Taipei City and eight in Taipei City). There are 5267 observations in total excluding those with incomplete information. We deleted outliers in which prices are higher (or lower) than average price plus (or minus) three times the standard deviation, and received 5079 observations in the database. We then used Google Maps to measure the distance from the house to the nearest MRT stations and found the administrative district to which they belong and the associated socioeconomic data from government statistical database. Table 1 provides the descriptive statistics of house prices from 2004 to 2012. It shows that the prices of houses within a 1-km radius around MRT stations have been increasing and are more diversified during the data years.

It is hard to find trading prices of a specific residential house for each of the nine years since houses are normally not traded frequently. We identified repeating measures of house prices by a matching process. That is, for each house that was traded between 2004 and

Table 1. Descriptive statistics of house prices in Great Taipei.

	Distance to MRT stations				Location			
	<500 m		>500 m		Taipei City		New Taipei City	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
2004	23.24	6.08	23.02	6.64	24.79	5.43	14.28	1.52
2005	29.41	9.67	26.41	6.15	29.71	7.01	16.48	.87
2006	29.34	9.08	29.63	7.61	32.27	6.69	18.41	2.10
2007	36.86	12.67	33.74	10.18	39.95	9.26	20.86	1.56
2008	39.26	10.97	39.54	10.78	43.92	7.67	24.16	1.75
2009	42.75	14.43	41.83	11.71	47.06	10.10	24.83	2.73
2010	52.88	13.47	52.14	14.24	57.48	10.16	31.62	1.66
2011	58.99	17.48	58.97	16.57	65.78	12.62	35.95	2.38
2012	67.40	15.86	63.92	19.42	71.53	14.17	45.72	13.88

Characteristics	All samples		<500 m		>500 m	
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.
Road width (m)	19.11	12.23	19.65	12.87	18.83	11.88
Size (Pin)	34.03	15.87	34.54	16.13	33.76	15.74
Age (Year)	22.97	11.63	22.57	11.90	23.17	11.48
Population den. (per m^2)	22.97	10.71	23.26	12.21	22.82	9.86

		Percentage		
		All samples	<500 m	>500 m
Type (elevator)	With	56.2	54.7	56.9
	Without	43.8	45.3	43.1
Zoning	Commercial	40.1	34.9	42.8
	Residential	59.9	65.1	57.2
City	Taipei City	71.5	61.4	76.6
	New Taipei City	28.5	38.6	23.4

Notes: Std. dev.: standard deviation; population den: population density.

2006, we matched it, for each year, with a house located in a nearby area and with similar characteristics including age, size, type of building, land use zoning, and the distance from MRT station, to form an object with repeating measures. Following the matching process, we received 69 objects (with 482 observations), most of which have nine measures on average. The variables included in the HLM model are described below.

House prices are in 10,000 New Taiwan Dollars (NT$) per ping (a customary unit of measurement in Taiwan which is equivalent to 3.306 square meters) and are deflated by the consumer pricing index announced by the Bureau of Statistics, Executive Yuen. The measurement of house price in NT$10,000 per ping may look odd to foreigners outside Taiwan. However, these measurements originated from the database provided by the Department of Land Administration, Ministry of the Interior of Taiwan. The prices used in the growth model were deflated by the consumer price indices to parse out inflation effects on the long-term price pattern. Using the original local customary unit of measurement instead of transformed data helps foreign investors to more straightforwardly examine the price trajectory of real estate in Great Taipei.

The size (*Size*) of the house transferred in the transaction is subject to the registration records in the local land office where the house is located. The size of the house is measured by unit ownership, which includes the individual unit and common areas. The individual unit covers the main building and the auxiliary building including the balcony, overhang, and rain shaft while the common areas include elevator cabs and open spaces within the lot and the estate, passages, corridors, staircases and landings, and all other common parts as specified on the title deed.

Two types of variables have been commonly used to define the proximity to the target object: the scale variable measuring the direct distance by miles/meters and the dummy variable indicating the distance, near to or far away, from the object within a certain radius. In analyzing the effects of the actual walking distance to light rail rapid transit stations (along the street network) and the perceived proximity to stations (measured by straight-line distance) on house prices, Hess and Almeida (2007) found that the effects are greater in the latter model than the former model. They concluded that apparent proximity to rail stations is an added locational advantage when compared with physical walking distance to the station. Lum, Koh, and Ong (2004) used dummy variables to denote each the proximity to the MRT stations (1 if within 300 m radius and 0 otherwise), expressways, bus stations, schools, and other neighborhood infrastructure or facilities. Addae-Dapaah and Lan (2010) also defined the proximity to MRT (1 if MRT located within 500 m and 0 otherwise), parks, libraries, and other infrastructure/facilities as dummy variables. Slightly different from the dichotomy dummy variable, Peng and Chiang (2015) defined six levels of proximity to hospitals from 0 to 3000 with an interval of 500 m.

For the proximity to the MRT stations, the strait-line distance is different from the actual walking distance for most houses in Great Taipei. Houses located within one kilometer walking distance from MRT stations are called "mass rapid transit residential." However, for Taipei citizens, 7 to 10 m of walking distance (around 500 m) to the MRT stations are the "golden distance" that is acceptable to most home buyers (HouseFun News, 2014). Therefore, we used Google Maps to manually measure the distance from the individual house to the nearest station within a one kilometer radius. The distance was then transformed into a dummy variable (*Distance*), which 1 denotes shorter than 500 m and 0 otherwise.

There are three more dummy variables, including (1) City where the house is located (*City*): 1 – Taipei City, and 0 – New Taipei City; (2) type of building (*Type*): 1 – building with elevator, and 0 – otherwise; and (3) land use zoning (*Zoning*): 1 – commercial use, and 0 – residential use.

The socioeconomic variables including population density, education level, and per capital income were collected from the government statistical database. The covariate *Time* consists of nine years from 2004 to 2012, of which 2004 is denoted as base year.

Furthermore, there was a nationwide banking emergency that coincided with the U.S. Great Recession caused by the subprime mortgage crisis in 2007–2008. We formulated a second model by adding the dummy variable ($D = 1$ if $2008 < \text{year} < 2012$; $D = 0$ otherwise) in the second model to test the effects of the recession on the growth pattern of house prices in Great Taipei.

Results

To examine the effects of house-specific features on the house prices, we first run a conventional cross-sectional regression model, assuming that each observation was independent from the others. The results showed that the house prices were significantly related to the width of the front road (–.48***), the type of building (11.17***), the size transferred in the transaction (–.22**), the city in which the house is located (21.55***), and the age of the house (.24*). We also developed the first-order autoregressive time-series model using the matched nine-year data. The results showed that the price of the previous period and size in the transaction significantly dominated the house price over time. We then examined

Table 2. One-way analysis of variance for house prices in Great Taipei.

Source	DF	Sum of squares	Mean square	*F* value	Pr > *F*
Model	8	89,576.43	11,197.05	70.50	<.0001
Error	474	75,277.40	158.81		
Corrected total	482	164,853.83			

$R^2 = .54$.

Table 3. Results of the null model.

Fixed/Random effects	Estimate	Standard error
Intercept (γ_{00})	42.89***	1.33
UN (1,1) (τ_{00})	79.48***	20.37
Residual (σ^2)	261.39***	18.08
−2 × log liklihood	4135	
Null model likelihood ratio test – Pr > ChiSq.	<.0001***	

***$p < .001$.

whether the time-invariant house-specific features affected the change patterns of house prices with the individual growth model.

One-way analysis of variance was carried out (Table 2) to confirm that the variability in the house prices in the nine points of time is significantly different from zero ($p < .001$). The inter-class coefficient of the null model (Table 3) presented that 23% variance of prices was from the heterogeneity among houses. This result confirmed that the HLM, in which differences among groups are incorporated, is appropriate to fit the data (Cohen, 1988). We then incorporated time-varying and time-invariant variables into the HLM of individual growth housing price model. Variance Inflation Factor tests identified there was no collinear problem among covariates at either one of the two levels.

The convergence criterion of the HLM (of individual growth) complete model was also met. The results of the mixed model (Table 4) show that random effects are associated with the intercept (π_{0i}) and the slope (π_{1i}) of time at Level 1. That is, there are price differences among houses, confirming the viability of using the HLM approach again. In addition, the autoregressive correlation (AR(1)) in the residual error at Level 1 is significant (.2334***), which is consistent with the pre-assumption of the research model.

The fixed effects (π_{0i}) show that at the original state (*time* = 0), only the city of the house location significantly affects the house prices (4.91†), indicating that the price of the residential properties in Taipei City was NT$49,000 higher than those in New Taipei City in average. The distance from the property to the MRT stations and other characteristics of the properties have insignificant effects on the price of that property at the original state.

The π_{1i} coefficients signify the change pattern of the house prices. The results show that time is positively correlated with the house prices (3.40**). In addition, two factors, the type of building and the city in which the property is located, have a significant effect on the housing price pattern. The price of the buildings with elevators grew faster than those without elevators, specifically by NT$10,517 per ping per year, signifying the residents' preference for occupying modernized buildings. The price of the houses with elevators increased NT$44,455 (=33,938 + 10,517) per ping per year in real terms. The price of houses located in Taipei City grew NT$54,942 per ping per year, which is higher than those located in New Taipei City by NT$21,004 per ping per year. The different change patterns have enlarged the differences of house prices between the two cities.

Table 4. Results of the complete HLM of individual growth model.

Variables		Estimates
Fixed effects		
π_{0i}	*Intercept* (γ_{00})	−14.9704**
	Distance (γ_{01}) (to MRT station)	.1156
	City (γ_{02}) (building is located)	4.9100†
	Age (γ_{03}) (initial year)	−.0065
	Size (γ_{04}) (transferred in transaction)	.0334
	Type (γ_{05}) (with elevator or without)	−.9163
	Width (γ_{06}) (road)	.0871
	Zoning (γ_{07}) (land use)	.5289
π_{1i}	*Time* (γ_{10})	3.3938**
	Time × *Distance* (γ_{11})	.3119
	Time × *City* (γ_{12})	2.1004***
	Time × *Age* (γ_{13})	.0071
	Time × *Size* (γ_{14})	−.0136
	Time × *Type* (γ_{15})	1.0517*
	Time × *Width* (γ_{16})	−.0241
	Time × *Zoning* (γ_{17})	−.1559
Income (ζ_{1i}) (per capita)		.1102†
Edu (ζ_{2i}) (education level)		.3442**
Density (ζ_{3i}) (population)		−.0782
Random effects		
UN(1,1) (τ_{00})		0
UN(2,1) (τ_{01})		−.8229
UN(2,2) (τ_{11})		1.2993
AR(1)		.2334***
Residual (σ^2)		39.9941
−2 × log liklihood		3220.20
Null model likelihood ratio test – Pr > ChiSq		<.0001***

***$p < .001$; **$p < .01$; *$p < .05$; $^{\dagger}p < .1$.

The time-varying covariates, both per capita income and the education level, have significant positive effects on the house prices, as expected (.11† and .34**, respectively). The effect of population density on the housing price is insignificant. One possible reason is that the population density in Taipei metropolitan has been high and had little change during the study period. The zoning structure also has an insignificant effect on the house prices. One possible reason for this insignificance is that residential and commercial mixed-use of buildings is common in Taiwan. Many residential buildings have some spaces occupied by commercial activities. The residential and commercial mixed-use narrows the value differentiation of land use zoning (Lin & Ma, 2007). All other characteristics of the houses, including frontal road width, size, and age, also have insignificant impact on the housing price, indicating that house buyers have no specific preference in these factors.

Unexpectedly, the effects of the distance from the residential house to the MRT station are insignificant on the original state of house prices and on price changes. This result is consistent with the findings of Portnov et al. (2009) and Mohammad et al. (2013). One possible explanation is that nearby MRT networks and well-developed bus transportation systems make it convenient for the residents to travel back and forth between their houses and the MRT station. MRT passengers receive a discount if they take buses as the transition tool. Furthermore, MRT routes have been expanding over the past decade to cover many administrative districts. The total length of MRT routes have expanded from 10 km to around 120 km, and the number of stations increased from 24 stations to 108 stations from 1998 to May 2015.The increasing spatial coverage of MRT networks and the bus system make it little different to the residents in Taipei region whether they live close to the MRT stations.

This implication echoes the findings of Shyr et al. (2013) that accessibility impacts of transit station on house prices declined with increases in the spatial coverage of transit systems.

The effects of the subprime debt crisis and the recession on the growth pattern of house prices

The second model incorporated a dummy variable to denote the presence of subprime debt mortgage crisis and the subsequent economic recession from 2008 to 2011. The results in Table 5 show that the overall growth pattern of the house prices was significantly increasing (4.03***) during the non-recession period. The average price dropped (−14.15**) during the recession but was climbing back (.8567*) throughout the recession period.

The financial crisis did not change the effects of most hedonic characteristics, including the proximity to the MRT stations, on the house prices. However, the positive relationship between the size of the house transferred under the transaction and the unit house prices increased during this period. These results indicated that the upper classes in Taiwan were

Table 5. Testing the effects of financial crisis on the growth pattern of house price in Great Taipei.

Variables		Estimates
Fixed effects		
π_{0i}	*Intercept* (γ_{00})	−7.9302
	Distance (γ_{01}) (to MRT station)	.2485
	City (γ_{02}) (building is located)	5.0328†
	Age (γ_{03}) (initial year)	−.0136
	Size (γ_{04}) (transferred in transaction)	.0034
	Type (γ_{05}) (with elevator or without)	−.0668
	Width (γ_{06}) (road)	−.0684
	Zoning (γ_{07}) (land use)	.4409
π_{1i}	*Time* (γ_{10})	4.0292***
	Time × *Distance* (γ_{11})	.5107
	Time × *City* (γ_{12})	2.0375***
	Time × *Age* (γ_{13})	.0099
	Time × *Size* (γ_{14})	−.0331*
	Time × *Type* (γ_{15})	.5709
	Time × *Width* (γ_{16})	−.0061
	Time × *Zoning* (γ_{17})	−.3659
Income (ζ_{1i}) (per capita)		.1083†
Edu (ζ_{2i}) (education level)		.2721**
Density (ζ_{3i}) (population)		−.8191
D (1 – 2008 < year < 2012; 0 – otherwise)		−14.1542**
D × *Time*		.8567*
D × *Distance* (γ_{18})		−1.6664
D × *City* (γ_{19})		1.9115
D × *Age* (γ_{20})		−.0228
D × *Size* (γ_{21})		.1925**
D × *Type* (γ_{22})		2.0851
D × *Width* (γ_{23})		−.1238
D × *Zoning* (γ_{24})		1.7296
Random effects		
UN(1,1) (τ_{00})		0
UN(2,1) (τ_{01})		−.4046
UN(2,2) (τ_{11})		1.2993
AR(1)		.0682***
Residual (σ^2)		32.1476
−2 × log *liklihood*		3220.20
Null model likelihood ratio test – Pr > ChiSq		<.0001***

***$p < .001$; **$p < .01$; *$p < .05$; †$p < .1$.

affected less by the financial crisis than the general public. In Taiwan, income share held by highest 20% was 54.81 times against that held by lowest 20% in 2005. According to the national statistics announced by the Executive Yuen, the top 20% of working families received 6.19 times the total income received by the bottom 20% of working families in 2010, up from 6.03 in 2004 and slightly lowered to 6.08 in 2014. Alternatively, the independent economist used self-reporting taxable income to estimate the inequality index and found that the times of top 20% families over the bottom 20% families was 99 in 2013 up from 55 in 2005 (Chu, 2014). Luxury real estates had appreciated in Taiwan since 2008 even during the economic recession lead by the US subprime mortgage crisis. According to the Knight Frank Prime Global Cities Index, the prices of luxury real estates dropped 5.5% in most countries but increased 15% in Taiwan in 2012. The upward trend of the prices of the luxury real estate came to an end in 2015 after the government announced to collect the Mansion tax and gave a broader definition to identify the high value homes for the annual property tax, according to the market report (Economic Daily News, 2015).

Conclusions

The contribution of this paper is to examine the effects of the proximity to the MRT stations and other house-specific features on the growth pattern of house prices at the individual level, which is different from previous studies that focused on those effects at industry level. The results of this paper showed that the proximity to MRT stations was irrelevant to the growth patterns of house price at the individual level in Taipei.

The results of the empirical model have implications both to the investors and the policy-makers. For the investors, the house prices in Taipei City have been growing at a faster pace, implying a higher return on the investment than those in New Taipei City for last decade. These results signify that the impacts of attributes on house prices not only vary at different time points but also show spatial variations, which are similar to the conclusion of Zmölnig, Tomintz, and Fotheringham (2014). In addition, the price changes of houses located within 500 meters from MRT stations is not much different from others throughout the cities, but the price of residential buildings with elevators grew faster than those without. This result indicates that an elevator-facilitated condominium one kilometer from an MRT station might generate a higher investment return than an older, smaller apartment near an MRT station. As for age, size, land use zoning, and front road width, these are of little importance for investment evaluations.

For the policy-makers, there is no evidence to show that the distance to the MRT station relates to appreciation in house price, indicating that the development of MRT routes may not be the most important attribute to increasing house prices, as suggested by socialist groups. Furthermore, close MRT networks may have the effect of diversifying people from downtown to the suburban areas. However, the high growth pattern of housing price over time in the two Taipei cities during the last decade still needs further discussion. People have long been moving to the urban areas that provide better and more job opportunities and higher-quality living. High population density and high zoning levels or other use regulation might lead to higher levels of housing prices (Glaeser, Gyourko, & Saks, 2006). This is an issue related to national spatial planning and is out of the research objectives of this study.

There are constraints with the data we use. The first constraint is the availability of the database only up to June 2012 so we were not able to examine the continuous price pattern thereafter. The second constraint is that the price of the house is reported by the realty companies rather than being the actual transaction price, which is available only starting in July 2012. This disruption in the type of data makes it difficult to carry out longitudinal analysis from the very beginning of the MRT services currently in place to date. The study can be verified with post-July 2012 sales transaction data when a longer term data-set of actual prices is available for repeating measures. Finally, the price pattern of the luxury real estates might be different from other residential houses in the market. Distinguishing these high value homes from the sample data may improve the accuracy of the price prediction of the property market.

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ORCID

Fen-may Liou http://orcid.org/0000-0002-6486-1024

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