Impacts of Transit Accessibility on Housing Prices in three Asian Cities[1]

Keywords: transit accessibility, green initiative, property values, hedonic prices

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Abstract

With much less trips generated by Kaohsiung MRT, the joint development projects around the stations are not as attractive as those in Hong Kong and Taipei. However, we find that properties adjacent to Kaohsiung MRT stations enjoy a price premium of 6% compared to the others. On the other hand, the price elasticity for distance to station is about 5% in Taipei and 4% in Hong Kong. The plausible explanation is that transit networks in Hong Kong and Taipei are more widespread than the one in Kaohsiung, therefore, properties in the vicinity of MRT stations do not posses significant advantage of transit accessibility. Most of the projects around Hong Kong stations are for commercial purposes while the majority of the projects in Kaohsiung and Taipei are for mixed uses. Additionally, the green initiatives do not have significant impacts on the three markets.

Theme: Climate impacts on behavior in property markets

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1 BACKGROUND

As one of the most successful Metro system in the world, Honk Kong MTR network attracts more than six millions of daily passenger rides. And the real estate projects were mostly development around the MTR stations. On the other hand, with over 2 million daily trips by MRT and more than 4 daily million trips by the Taipei transit system, it is shown that MRT stations are very attractive to retailers, bankers, consultant executives, and commuters. In other words, we seek to explore the price premium for better transportation accessibility before and after the completion of major transportation projects. The results can be used to evaluate the effectiveness of transit-oriented development, a policy which is recently initiated by the city government.

Additionally, various green building certificate systems were applied to evaluate the efficiency of energy consumption as well as the eco-friendliness of the building during the construction and operation period. To analyze how accessibility, amenity, and green building certificate affect property prices, we apply hedonic price method to estimate model parameters using two types of data sources, that is, the transition data of Taipei and Kaohsiung metropolitan area[2] provided by the Ministry of the Interior; and the asking price data provided by housing agents in Taipei and Hong Kong. The variables of our models include attributes related to the property, the neighborhood, and the accessibility measured by the distances to transportation terminals. The functional forms of our models consist of linear, semi-log linear, log-linear, and Box-Cox transformation. By the comparison of hedonic functions of 2009, we conclude that properties adjacent to Kaohsiung MRT stations enjoy a price premium of 6% compared to the others. On the other hand, the price elasticity for distance to station is about 5% in Taipei and 4% in Hong Kong. The plausible explanation is that transit networks in Hong Kong and Taipei are more widespread than the one in Kaohsiung, therefore, properties in the vicinity of MRT stations do not posses significant advantage of transit accessibility. Most of the projects around Hong Kong stations are for commercial purposes while the majority of the projects in Kaohsiung and Taipei are for mixed uses. Additionally, the green initiatives do not have significant impacts on the markets of Hong Kong and Kaohsiung, but do have significant and positive impact on the market of Taipei.

[2] The metropolitan area of Taipei includes Taipei City and Taipei County (renamed as Xinbei City since 12/25/2010), and Keelung City. The metropolitan area of Kaohsiung includes the majority of cities and townships in Kaohsiung County and part of Pintung County. The total population of Taipei and Kaohsiung metropolitan areas, as of 09/30/2008, are around 7,000,000 and 2,80,000, respectively.

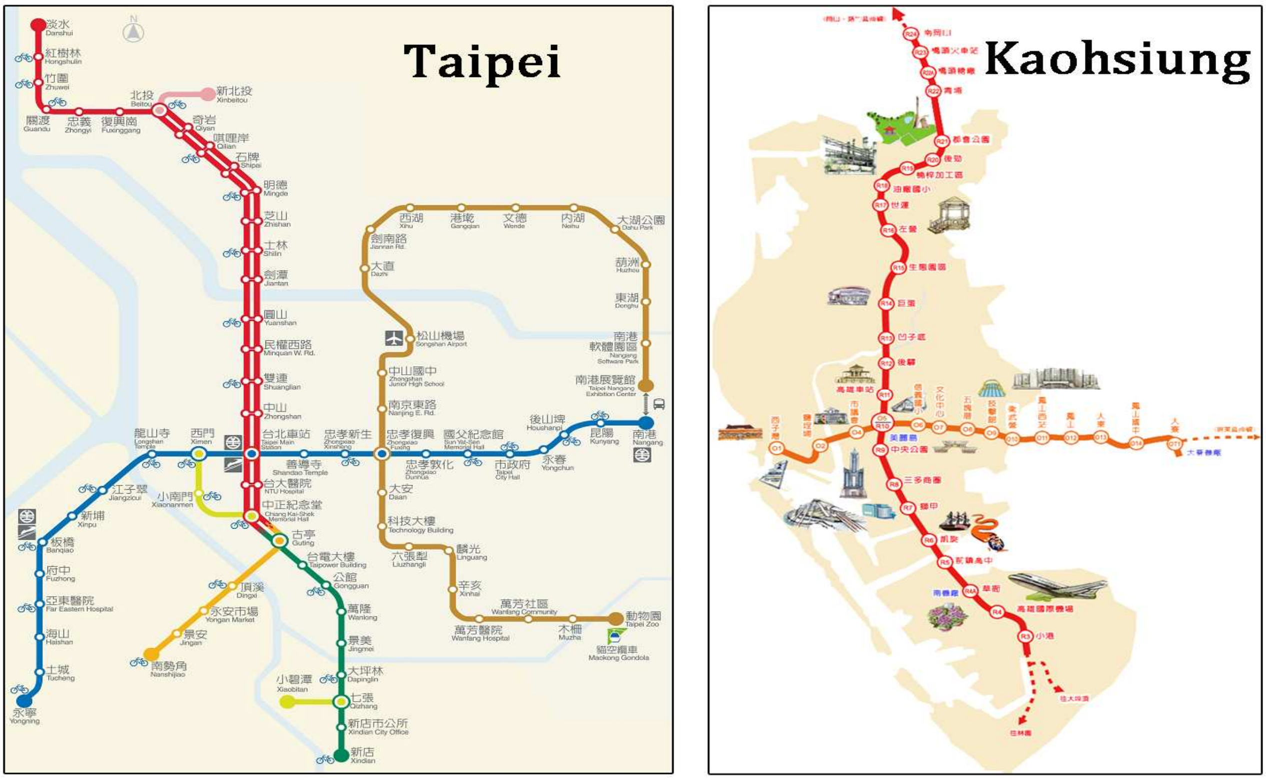

Figure 1: The Public Transport Network in Taipei and Kaohsiung Metropolitan Area

Figure 2: The MTR Network in Hong Kong

2 HEDONIC PRICES

Hedonic price theory is associated with the introduction of the term in a paper by Sherwin Rosen (1974), using ideas that had already been introduced by a number of economists in the 1960s (see, for example, Lancaster 1966). Rosen uses a utility-maximizing approach to derive implicit attribute prices for multi-attribute goods under conditions of perfect competition, where each attribute has a unique implicit price in equilibrium. Perfect competition, however, rests on assumptions of perfect information, which is not normally approximated in markets for housing or other real estate markets.

Perfect competition is however not a necessary assumption for empirical hedonic price studies. Barzel (1989) approaches multi-attribute goods in a more dynamic way, by building on the insights of property rights theorists such as Demsetz (1967). Webster and Lai (2003) extend Barzel’s theory to spatial economics in a way that explicitly takes dynamic processes and imperfect information into account. From such a dynamic standpoint, empirical hedonic price models do not produce stable estimates of equilibrium prices, but rather snapshots of transitional conditions. For example, a discovery of two centers with a metropolitan impact does not necessarily invalidate the common monocentric assumption; it could be a transitional stage where a declining and an emerging center both impact the willingness to pay of market participants for a finite time period – a reflection of asymmetric and imperfect information among buyers and sellers.

In general, hedonic price models aim at disentangling the attributes of a good from one another for the purpose of estimating implicit prices. In housing models, the price or rent is a function of various attributes, typically divided into structural and location attributes. Location attributes can be further subdivided into general accessibility and localized neighborhood effects.

Regression techniques make it possible to estimate the implicit price for each attribute. Linear models are usually avoided, since the assumption of constant marginal implicit prices is untenable unless there are constant returns to scale in production or costless repackaging of two or more bundles. The most common non-linear models include log-linear, semi-log, and

Box-Cox-transformed functions[3]. The log-linear and semi-log functions are pre-specified functions, while Box-Cox functions uses an iterative procedure that maximizes the log-likelihood of the function within a pre-specified family of functions. Such maximization ensures a more desirable distribution of the error term than with less flexible estimation techniques.

In this study, we use the log-linear functional form, which is both compatible with the underlying economic theory and relatively simple. The log-linear function has the additional interpretive advantage that the estimated coefficients correspond to average attribute elasticities. All pre-specified functional forms – including the log-linear function – has the advantage of allowing direct comparisons of quantitative attribute effects across markets.

On the other hand, it is often advisable to compare the results of different functional forms in order to identify non-robust estimates. For this reason, we estimated semi-log functions for all regions as well as simple left-hand-side and simple both-side Box-Cox functions for two regions (Hsinchu and Tainan). The log-linear models exhibited higher coefficients of determination and closer-to-normal distributions of residuals than the corresponding semi-log functions in all cases, but the qualitative effects of the variables were remarkably robust[4], with the exception of HSR station accessibility in the Tainan region and the "height" variable in allbut one region. The Box-Cox functional forms for Hsinchu and Tainan yielded identical qualitative conclusions as the log-linear model. Indeed, the both-side model for Hsinchu converged with $\lambda = 0.01$, which is virtually identical with the log-linear model (defined as $\lambda = 0$)[5].

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[3] The simple-left-hand-side Box-Cox transformation is $X_1^{\lambda} = \beta_1 + \beta_2 X_2 + \ldots + \beta_i X_i + \ldots + \beta_k X_k$. The simple both-side Box-Cox transformation is $X_1^{\lambda} = \beta_1 + \beta_2 X_2^{\lambda} + \ldots + \beta_i X_i^{\lambda} + \ldots + \beta_k X_k^{\lambda}$; where $X_i^{\lambda} = (X_i^{\lambda} - 1) / \lambda$ for $\lambda \neq 0$ and $X_i^{\lambda} = \ln X_i$ for $\lambda_i = 0$.

[4] The main attribute effects tend to be similar across functional forms, while many of the less important attributes tend to produce different quantitative and qualitative conclusions depending on the choice of functional form and the specification of independent variables (see Butler, 1982). Our results indicate that among the statistically significant effects that were identified using the log-linear model, the only questionable qualitative result is the HSR station accessibility effect in the Tainan region.

[5] For Tainan, the corresponding $\lambda = .168$. For both Hsinchu and Tainan, the simple-left-hand-side model was associated with lower log likelihood than the simple both-side model. The semi-log function is a special case of the simple left-hand-side model.

The functional forms of the hedonic models include: 1) Semi-log; 2) Inverse semi-log; 3) Double-log; and 4) Box-Cox transformation, as shown below.

1. Semi-log

$$\ln P = \alpha_0 + \sum_{i=1}^{m} \beta_{im} Z_{im} + \sum_{i=1}^{n} \beta_{in} D_{in} + \varepsilon_i \quad (4.1)$$

2. Inverse semi-log

$$P = \alpha_0 + \ln \sum_{i=1}^{m} \beta_{im} Z_{im} + \sum_{i=1}^{n} \beta_{in} D_{in} + \varepsilon_i \quad (4.2)$$

3. Double-log

$$\ln P = \alpha_0 + \ln \sum_{i=1}^{m} \beta_{im} Z_{im} + \sum_{i=1}^{n} \beta_{in} D_{in} + \varepsilon_i \quad (4.3)$$

Where,

P: housing price,

Z: explanatory variables,

D: dummy variables,

β: coefficients,

α: constant term,

ε: random error.

4. Box-Cox

$$Y(\lambda_2) = X(\lambda_1)\beta + \varepsilon = \beta_1 X_1 \lambda_1 + \beta_2 X_2 + ... + \beta_p X_p + \varepsilon,\ \varepsilon \sim N\left(0, \sigma^2 I\right) \quad (4.4)$$

3 TRANSIT ACCESSIBILITY AND HOUSE PRICES

There are many studies of the effect of accessibility on housing development analyzing local transit networks. Among them, Cervero (1994) found that for Bay Area cities served by BART, residents living near rail stations were around five times as likely to commute by rail transit as the average resident-worker in the same city. He concluded that the strongest predictors of whether station-area residents commuted by rail were whether their destinations were near rail stations and whether they

could park for free at their destinations. Moreover, neighborhood density and proximity of housing to stations were also related to rail travel. He also suggested that if transit-based housing is to reap significant mobility and environmental benefits, it must be accompanied by transit-based employment growth and programs that pass on true costs to motorists and parkers. There are many hedonic studies of the effect of accessibility on housing prices related to local transit networks.
Armstrong and Rodriguez (2006) analyze a slightly more extensive rail network than in most hedonic studies. They estimated accessibility benefits of rail services in eastern Massachusetts, including multimodal accessibility to commuter rail stations and distance from the rail right-of-way. The results were inconclusive, except that proximity to commuter rail right-of-way produced a significant negative effect on property values, which probably reflects negative externalities such as noise.

Bowes and Ihlanfeldt (2001) suggest that railroad station accessibility should affect property values since such access reduces commuting costs. This should help attract retail activity from localities further away from stations, other things being equal. Possibly countering these positive effects are negative externalities such as noise and better access for criminals. Their results - from Georgia in the United States - suggest that stations that are located sufficiently far away from the urban core tend to attract new residential development.

The most comprehensive studies of rail networks have been conducted in the Netherlands in a number of theoretical and empirical studies by Debrezion, Pels, and Rietveld (for example 2006a; 2006b). Unlike other authors, they have adopted a multi-regional perspective that extends to the Netherlands as a whole. Debrezion et al. (2006a) use a hedonic pricing model to analyze the impact of the railroad network on house prices in the Netherlands. They use several access variables, including station accessibility, train service frequency and track proximity. Among other findings, they estimated that housing in close proximity to railroad stations command market prices that are about 25 percent more expensive than equivalent housing at a distance of 15 kilometers or more. A problem with their approach is that they analyzed the Netherlands as a whole rather than just the

Randstad conurbation; the use of several spatially segmented markets in the same hedonic price function is associated with biased estimates of attribute effects (Palmquist 1991).

Studies of the regional enlargement of the Stockholm region in Sweden show that the radius of the price-distance gradient increased as a result of improved rail accessibility. Residential property prices in Uppsala could be partly explained by their time distance from downtown Stockholm after the introduction of a frequent 45-minute commuter train service with discounted fares for daily commuters (Andersson and Andersson, 2008). And hedonic estimates have proven that accessibility of high speed rail stations, if well connected and integrated with local transit network, have significant effects on housing prices in Taiwan's major metropolitan areas. (Andersson, Shyr and Fu, 2010) (Andersson, Shyr and Lee, 2010)

With sufficiently good information flows, improved accessibility will be capitalized in land values in conjunction with the initial investment decision. The normal case is however imperfectly informed markets, due to uncertainties regarding the credibility of decisions as well as future impacts of investments on the economy as a whole. The overall effect is therefore likely to be gradually incorporated into house prices, with distinct price effects that correspond to the sequence of relevant events: station location decisions; the commencement of construction; the opening of the line; and the cumulative experience from consuming transportation services. The first three effects should have been fully incorporated in the land value observations that we analyze in this paper, while the service experience component may have been capitalized in land values to a limited extent.

Yu and Wong (2005) studied such a temporal sequence in their analysis of the land price effects from a proposed tunnel project in Hong Kong. Their results show that expectations of improved accessibility had been capitalized in house prices to a substantial extent well before the completion of the tunnel. They suggest that such expectation effects may enable governments to fund infrastructure investments by selling land in areas with contingent accessibility benefits.

A related topic is the spatial structure of infrastructural impacts. This is particularly relevant in the present context, since some of Taiwan's high-speed rail stations are in remote suburban locations.

Sasaki, Ohashi, and Ando (1997) argue that market activity will not lead to a spatial dispersion of economic activities when an extensive network is implemented. They point out that the stock effect of existing lines favors previously developed regions, implying that new lines in remote regions improves the accessibility of central regions as well.

Sasaki et al. (ibid.) do however not take the possible spatial differentiation of transaction costs into account. If such cost heterogeneity is included, it is still possible that the reinforcement of pre-existing agglomeration economies does not materialize. For example, a property developer with substantial land holdings around stations may indeed bring about spatial dispersion, since unified land ownership is associated with low transaction costs. The transaction cost savings may therefore offset the sunk costs that in the past caused agglomeration economies, as long as long-established areas have more dispersed land ownership.

4 AMENITY, GREEN INITIATIVES AND HOUSE PRICES

The literature on the effect of disamenities (and amenities) on residential housing prices is long and exhaustive. The list of disamenities includes: power lines, power plants, gas station, airports, trailer parks, beltways, traffic flow, noise.(Thomas M. Carroll and Mike Clauretie, 1999).

The benefits of these facilities and services are also capitalised into urban property values (Damm et al. 1980).The distance from CBD, from social and civic centers have often been modeled in monocentric models (e.g., Alonso, 1965) or multicentric models (e.g., Dubin and Sung, 1987). “Not in my back yard”(NIMBY) movements typically exemplify community opposition to services for stigmatized populations. Such resistance frequently involves concerns over personal security, declining property values, or a generalized perceived threat to the neighborhood’s quality (Dear and Wolch, 1987).

“Environmentally conscious construction practices can markedly reduce site disturbance, the quantity of waste sent to landfills, and the use of natural resources during construction. It can also minimize the prospect of adverse indoor air quality in the finished building” (Gottfried, 1996).

There is another ‘benefit’ of green construction, which is social value – a compound function of public image, marketability, resource conservation, and corporate responsibility. For certain owners, the ‘feel-good’ factor may tip the scales in favor of sustainability, where “…choices being made to incorporate sustainability into design and construction are a result of value the client sees in the economic and environmental benefits of ‘green’.(Koga, J. E., and Lehman, T. 2008).

There is some data to support the claim that financial benefits of sustainable construction are “…between $50 and $70 per square foot in a LEED building, over 10 times the additional cost associated with building green” (Kats, G. H. 2003), For example, the embodied energy and cost associated with the production of building materials, while theoretically categorizable as a lifecycle cost, are tertiary costs borne by the greater population and perhaps thus are best associated with the societal value of green buildings. Similarly, the purchase of renewable energy from alternate sources and the purchase of carbon offset credits also represent indirect holistic value.

Greater public awareness and the corporate responsibility agenda are adding further corporate value to aspects of building sustainability that previously had to be judged solely on financial returns.(Rawlinson, S. Sustainability Offices, 2007).

5 THE DATA

The observations on transaction prices of Taipei and Kaohsiung in 2008 and structural characteristics were obtained from the Department of Land Administration of the central government. The transaction data of Taipei and Hong Kong were collected from housing agents in 2009 and in the fourth quarter of 2008, respectively. The education data for Taipei and Kaohsiung are obtained from the Ministry of Finance. The neighborhoods correspond to districts in the core cities and to townships in the rest of the metropolitan areas. A suggested income variable was unfortunately unavailable for districts, but the correlation between average income and the percentage of residents with at least two years of college education is very high in districts and suburban townships, so the education variable is in effect also a proxy for income. The distance measurements are proxies for house-specific access to the MRT and HSR station, the international airport, the city center, and major shopping halls, respectively. The distance data correspond to the shortest route for motor vehicles according to a popular GIS program that covers the entire road network of Taiwan; *PaPaGo R12*, and estimates provided by Google map for Hong Kong data.

The neighborhood attributes “commercial zone” and “residential zone” refer to Taiwanese zoning regulations, which are more flexible than in many other jurisdictions. Taiwan’s cities have retained a mixed-use character since “residential zones” allow commercial use on the first and second floors of apartment houses and townhouses. “Commercial zones” allow for some residential use on higher floors. For example, downtown residential zones are often used for high-rise apartment blocks with high-value commercial use such as banks and luxury retailing on the first two floors. Moreover, land use regulations tend to be somewhat haphazardly enforced compared with European or North American cities (Bernstein, 2007).

Additionally, the transaction data for properties with green building certificates is not available in Taipei and Kaohsiung. Therefore, we use the estimated housing price data based on the average discount rates between asking prices and the transaction prices during the four quarters of 2009 to calibrate our hedonic functions[6].

6 ESTIMATION RESULTS

[6] The average discount rates between asking prices and transaction prices of the Taipei housing market are 19.6% for the 1st quarter, 15.07% for the 2nd quarter, 15.85% for the 3rd quarter, and 14.15% for the 4th quarter of 2009.

The hedonic analysis makes use of sales prices rather than rents, which accounts for most transactions involving residential property. In addition, sales prices reflect expectations of future developments, and should therefore - unlike rents - reflect potential long-term future benefits of new or planned infrastructure investments. Table 1 is a list of all variables which specifies measurement units as well as the abbreviations that are used in estimation. Table 2 Table 3 gives the means and standard deviations of the original untransformed variables. Table 4, 5, 6, and 7 show the estimation results of the log-linear functions as well as the Box-Cox transformation for properties transaction data in the three cities. It should noted that Table 5 shows the estimated result for the transaction data from housing agents in the CBD districts of Taipei City, while Table 7 exhibits the result of the transaction data provided by the Ministry of Interior for the entire Taipei metropolitan area which includes Taipei County and Keelung City.

It is not surprising that all the structural, neighborhood, and accessibility attributes have the expected signs in these hedonic functions. And the green building certificate does affect the housing prices in Hong Kong and Taipei. Another interesting finding is that the distance to MRT station and the distance to airport exhibit various effects among the three cities. For example, the elasticity of distance to CBD is about 15%, except for the Taipei metropolitan model, while the elasticity of distance to a MRT station ranges from 5% to 7% - the highest value appear in the model of Taipei City. The plausible explanation is that the MRT network is very concentrated in the central city of Taipei that creates an agglomeration effect. On the other hand, the distance to international airports exhibit negative effects on housing prices in Hong Kong and Kaohsiung, except for Taipei metropolitan. The possible reason is that Song Shan Airport located at the center of Taipei City - less than 2 km from the CBD, as a result, the NIMBY effect was deducted by accessibility effect to the CBD. Nevertheless, Table 5 shows the negative effects of other NIMBY facilities on housing prices. Both power station and gas station have significant and negative effects on housing prices.

7 FINAL REMARKS

According to the above, we conclude that green building certificate does affect the housing prices in Hong Kong and Taipei. And except for a few exceptions, the elasticity of distance to a MRT station ranges from 5% to 7% in three metropolitan areas, which is about one half of the elasticity of distance to CBD. Although our study suggests that both power station and gas station have significant and negative effects on housing prices in the CBD of Taipei City, it is better to conduct the estimation of the data from all three metropolitan areas to diagnosis if any cross sectional differences do exist among the three cities.

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Table 1 List of variables with units of measurement and abbreviations

Variable	Unit of Measurement	Abbreviation	Data Source
Housing transaction price	Million TWD	Price	A
Floor area	100 m^2	Area	A
Location of floor	Number	Floor	A
Total number of floors	Number	Height	K
Age of house	Year	Age	A
Located within an apartment or not	Dummy	Apart	T, K
Street frontage lot or not	Dummy	Corner, Strfrt	K
Road Width	Meter	RW	
Remaining years for permit expiration	Year	Years	H
Population density	1000 residents/Km^2	PD	H
Percentage of residents with foreign passports	%	For	H
Percentage of home ownership	%	Owner	K
Percentage of residents with college degree	%	Edu	K
Located at the central city or not	Dummy	City	T, K
Distance to CBD	Kilometer	CBD	A
Distance to local CBD	Kilometer	LCBD1	T
Nearest large hospital within 100 m or not	Dummy	DH	T
Distance to the nearest power station	Kilometer	DE	T
Distance to the main train station	Kilometer	TR	K
Distance to the HSR Zuoying station	Kilometer	HSR	K
Distance to the nearest gas station	Kilometer	DG	T
Distance to the nearest shopping mall	Kilometer	Shop	T & K
Number of parking lots within 400 m	Number	MP	T
Number of convenience stores within 400 m	Number	MC	T
Distance to international airport	Kilometer	Air	T, K, H
Distance to the nearest MRT station	Kilometer	MRT	A
Number of bus routes within 400 m	Number	MB	T
Zone coding	Dummy	Com, Res	T & K
With or without green building certificate	Dummy	GBC	T, H

Note: A for all, T for Taipei, K for Kaohsiung, and H for Hong Kong

Table 2: Descriptive Statistics of Taipei and Kaohsiung Housing Data in2008

Type	Taipei				Kaohsiung			
Variable	Min	Max	Mean	Std.	Min	Max	Mean	Std.
Price	2.35	48.68	20.78	11.12	0.30	205	10.58	8.36
Age	1.92	45	35.41	10.71	0.17	45.83	22.32	11.23
Lot	32	290.9	95.9	58.42	0.04	1783	26.80	46.31
Area	55.26	385.8	189.8	91.34	18.36	1939	103.1	66.04
Edu	37.23	59.39	45.50	6.70	37.23	64.18	50.40	7.31
TR	0.879	12.8	5.70	3.90	0.41	15.1	6.66	3.46
MRT	0.359	2.8	1.13	0.58	0.01	12.1	1.55	1.54
Air	2.5	13.8	7.60	3.01	0.51	15.8	6.67	3.06
RW	8	47	19.40	10.13	4	100	21.53	13.15
CBD	2.9	18.2	10.03	4.14	0.6	20.3	7.52	4.14
LCBD1	1.2	18	8.06	4.17	0.284	20.2	9.85	4.56

Table 3: Descriptive Statistics of Taipei (*2009*) *and Hong Kong Housing Data* (*Q4 of 2008*)

Type	Taipei				Hong Kong			
Variable	Min	Max	Mean	Std.	Min	Max	Mean	Std.
Price	3.48	106.74	13.26	7.84	0.40	8.00	2.14	1.06
Area	0.19	3.99	0.82	0.47	0.20	1.37	0.59	0.16
Floor	2.00	24.00	12.00	6.50	1.00	70.00	17.50	11.49
Age	1.10	45.40	19.90	10.37	1.00	61.00	16.96	8.52
Years	NA	NA	NA	NA	2.00	100.00	43.78	16.95
GBC	0.00	1.00	0.10	0.30	0.00	1.00	0.05	0.23
Strfrt	0.00	1.00	0.40	0.40	NA	NA	NA	NA
CBD	0.01	4.76	2.20	0.95	1.00	38.50	16.16	10.48
Air	NA	NA	NA	NA	2.00	50.80	36.58	8.62
MRT	0.00	1.27	0.31	0.18	0.00	12.00	1.55	2.04
DH	0.00	1.00	0.30	0.50	NA	NA	NA	NA
DE	0.01	6.07	0.80	2.92	NA	NA	NA	NA
DG	0.06	2.88	0.70	0.51	NA	NA	NA	NA
MP	1.00	4.00	3.20	0.70	NA	NA	NA	NA
MC	1.00	5.00	1.81	1.20	NA	NA	NA	NA
MB	2.00	32.00	15.20	9.40	NA	NA	NA	NA
PD	NA	NA	NA	NA	783.00	52.12	20.49	17.17
Edu	NA	NA	NA	NA	15.00	39.90	24.04	5.91
For	NA	NA	NA	NA	0.17	4.96	1.21	1.25

Table 4 Hedonic Price Functions of Hong Kong Housing Data (*Q4 of 2008*)

Model	Double-log		Box-Cox	
Variable\Statistics	Coefficient	t-value	Coefficient	t-value
Constant	-5.032	20.742**	-0.052	-13.124**
Area (＋)	1.356	76.437**	0.069	55.664**
Floor (＋)	0.055	9.648**	0.066	10.027**
Age (－)	-0.090	11.041**	-0.114	-11.953**
Years (＋)	0.038	3.266**	0.029	5.298**
GBC (＋)	0.051	2.490**	0.108	0.559
CBD (－)	-0.153	-9.282**	-0.288	-16.644**
Air (＋)	0.088	7.500**	0.112	11.921**
MRT (－)	-0.005	-1.287	-0.046	-1.482
PD (＋)	0.067	9.139**	0.000	4.380**
Edu (＋)	0.322	6.559**	0.238	7.676**
For (＋/－)	0.049	3.979**	0.006	0.077
Lamb (λ)	NA	NA	0.834	4.435
Theta (θ)	NA	NA	0.448	6.521
Log Likelihood	NA		-9270.001	
Adjusted R^2	0.843		0.856	
No. of Sample	1889			

Note: * for 95％ confidence level, ** for 99％ confidence level

Table 5 Hedonic Price Functions of Taipei Housing Data in 2009

Model	Double-log		Box-Cox	
Variable\Statistics	Coefficient	t-value	Coefficient	t-value
Constant	6.124	4.931**	3.560	3.637**
Area (＋)	0.367	17.103**	0.034	15.104**
Floor (＋)	0.039	2.485*	0.002	1.742
Age (－)	-0.028	-1.727*	-0.002	-1.437
GBC# (＋)	0.241	4.122**	0.032	1.965**
Strfrt (＋)	0.054	2.416*	0.003	1.481
CBD (－)	-0.243	-6.366**	-0.029	-8.386**
MRT (－)	-0.249	-9.773**	-0.032	-10.061**
DH (－)	-0.150	-6.066**	-0.071	-4.725**
DE (＋)	0.079	5.867**	0.002	8.748**
DG (＋)	0.076	2.873**	0.001	3.553**
MP (＋)	0.335	5.635**	0.041	6.432**
MC (＋)	0.098	4.706**	0.029	7.674**
MB (＋)	0.087	2.920**	0.017	4.441**
Lamb (λ)	NA	NA	0.27	4.051
Theta (θ)	NA	NA	0.01	3. 326
Log Likelihood	NA		-6758.116	
Adjusted R^2	0.832		0.874	
No. of Sample	897			

Table 6 Hedonic Price Functions of Kaohsiung Housing Data in 2008

Model	Double-log		Box-Cox	
Variable\Statistics	Coefficient	t-value	Coefficient	t-value
Constant	0.209	1.374	0.507	0.169
Age (－)	-0.085	-20.542**	-0.077	-8.199**
Height (＋)	0.091	3.760**	0.138	1.730*
Area (＋)	0.312	18.412**	0.345	8.647**
Floor (＋)	0.651	32.055**	0.690	5.419**
Shop (＋)	0.264	18.193**	0.292	3.187**
Apart (＋)	-0.163	-6.614**	-0.115	-4.431**
Width (＋)	0.060	5.999**	0.079	2.221*
Com (＋)	0.377	13.393**	0.433	9.164**
Res (＋)	0.270	11.182**	0.223	18.228**
CBD (－)	-0.161	-16.519**	-0.142	-15.800**
HSR (－)	-0.107	-9.854**	-0.128	-14.422**
MRT (－)	-0.072	-11.015**	-0.084	-11.270**
Air (＋)	0.108	10.720**	0.128	2.453**
Education (＋)	0.385	11.848**	0.448	11.131**
City (＋)	0.040	3.083**	0.066	2.066**
Lamb (λ)	NA	NA	0.250	9.958
Log Likelihood	NA		-1138.818	
Adjusted R^2	0.851		0.867	
No. of Sample	2999			

Table 7 Hedonic Price Functions of Taipei Housing Transaction Data

Model	Double-log		Box-Cox	
Variable\Statistics	Coefficient	t-value	Coefficient	t-value
Constant	-1.133	-5.947	-0.759	-2.691
Age	-0.086	-13.877**	-0.074	-8.254**
Height	0.072	4.074**	0.037	4.711**
Area	0.108	6.567**	0.140	5.791**
Floor	0.935	47.499**	0.897	49.868**
Shop	0.413	6.734**	0.293	18.911**
Apart	-0.092	-3.035**	-0.033	-2.419**
Width	0.036	3.372**	0.015	7.520**
Com	0.129	3.548**	0.058	3.930**
Res	0.119	3.569**	0.053	3.630**
CBD	-0.064	-3.794**	-0.031	-1.500
HSR	-0.156	-14.302**	-0.135	-2.654**
MRT	-0.062	-9.510**	-0.049	-3.172**
Air	-0.062	-3.565**	-0.096	-3.680**
Education	0.868	19.704**	0.954	13.182**
City	0.404	22.463**	0.439	21.050**
Lambda	NA	NA	0.327	7.129
Log Likelihood	NA		-1297.803	
R^2	0.827		0.878	
No. of Sample	7369			