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Measuring residential property values in Hong Kong

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Abstract *The elements of sales comparison for residential property depend on a package of inherent attributes that are valued by consumers. These attributes can be classified into the following categories: structural, physical, neighbourhood and environmental. A model that incorporates adjustments for floor area, age, views and amenities such as availability of recreational facilities is presented and discussed. A multiple regression analysis with transactions-based data, using weighted least square to determine the discrete estate-type induced price effect in the Hong Kong housing market, is also presented. The paper demonstrates how the view of negative housing attributes is capitalised into house prices. Specifically, it is shown that the residential property values are higher for estate-type housing properties, and lower for dwelling units with a cemetery view.*

Introduction

Residential property is a multi-dimensional commodity, characterized by durability, structural inflexibility as well as spatial fixity. Each residential unit has a unique bundle of attributes: its accessibility to work, transport, amenities, the structural characteristics, neighbourhood, and environmental quality (Ridker and Henning, 1967; Muth, 1969; Stegman, 1969; Kain and Quigley, 1970; Evans, 1973; Lerman, 1979). A house represents not only a collection of structural characteristics but also a set of location-specific characteristics. At the local level, appraisers and market analysts have been increasingly interested in the impact of new developments on the location, or vice versa. Studies concerning the location, environmental and physical aspects of a property can be regarded as inputs to the basic valuation procedure.

Modern urban theory is a distinct branch of microeconomics because it extends traditional economic theories of market behaviour to incorporate space consumption and locational preference. Utility-maximizing households choose a location to live so that housing services and accessibility are purchased jointly. House price accessibility and amenities are strongly connected. Physical accessibility determines the time and cost of travel to other locations. However, many amenity factors could affect the demand for housing and the utility of households. For example, a good social neighbourhood amenity is

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expected to produce a positive effect on property values. Cheshire and Sheppard (1995) have included neighbourhood amenities in their hedonic analysis. They found that the local amenities could influence land price. By dropping any set of the amenity variables, the results in their model were shown to be performing significantly less satisfactorily. The choice of a bundle of housing attributes can be extended to include water-related open space and proximity to bodies of water of these characteristics (Brown and Pollakowski, 1977). A hedonic equation can be used to estimate implicit price, then estimate how the values of such location-specific characteristics are capitalized into house prices.

Higher-income households may be willing to pay more for housing to maintain neighbourhood homogeneity (Goodman and Thibodeau, 1998). Structural characteristics, location-specific factors, and neighbourhood characteristics may define various sub-markets. Schnare and Struyk (1976) suggest that housing market segmentation occurs when households' demand for particular structural or neighbourhood characteristics is highly inelastic and the preference is shared by a relatively large number of households. Goodman and Thibodeau (1998), on the other hand, argue that housing market segmentation may be attributable to spatial differences in structural characteristics, neighbourhood amenities, or some combination of both.

These viewpoints recognize that housing is a heterogeneous commodity distinguished by a wide variety of attributes. The components of housing units within a metropolitan area cannot be assumed to be similar. On the demand side, assuming a given spatial distribution of preferences and income over households, a distribution over space of demands for these attributes may be envisioned. The housing market is viewed as consisting of implicit markets for each of the attributes of housing (Rosen, 1974). House prices are determined by the demand for attributes, not only of the dwelling units themselves, but also of the region in which the units are located. In Hong Kong, for example, one attribute that might affect the price of a dwelling unit is the type of housing estate. Newly-developed large housing estates are generally exclusive complexes which tend to have a private clubhouse, which often include a full range of recreational facilities, such as private swimming pool, landscaped garden, gymnasium, and various kinds of sports facilities. It is thus argued that estate-type dwelling units have higher house prices than non-estate-type units that lack these facilities. In addition, a view of a cemetery was introduced as a negative neighbourhood attribute. In Chinese societies, the view of a cemetery is usually regarded as bad luck. There have been comparatively few detailed studies of local housing markets that include as housing characteristics estate-type properties and negative housing attributes such as an unattractive view. Studies that combine these factors generate interesting results.

In this study, the discussion of the choice of a bundle of housing attributes is extended to include estate-type of the dwelling unit and a view of a cemetery. After a discussion of the value placed on these housing attributes by

households, a methodology that extends previous applications of hedonic price equations is developed.

Data and methodology

House prices for dwelling units are determined by the consumer's evaluation on a bundle of attributes. Specifically, a hedonic equation helps to explain house prices in terms of their own characteristics; each of these housing attributes is assumed to be implicitly priced. The utility-bearing attributes include the physical characteristics of the property; location of site in relation to employment centres and other recreational facilities (accessibility); social and economic characteristics of neighbourhood, including the presence of amenities, views, schools and community services.

Since the number and nature of influences on the house prices are large and heterogeneous, house prices cannot simply be determined by the individual characteristics of the dwelling itself. Consequently, an analysis of the effects on the elements of comparison must be preceded by careful examination of the separate influences of various attributes.

A feasible approach in using the hedonic regression is to choose a sample with similar locational characteristics and income groups that are supposed to have homogeneous tastes so that the net effects of various internal attributes and location specific factors of the neighbourhood are similar. For the purpose of this study, four large residential estates were covered, which consisted of small- to medium-sized dwelling units. The four housing estates studied were Mayfair Garden, Tsing Yi Garden, Green Field Garden and Ching Wah Court. In addition, several non-estate type properties were included. The mean age of the units is 12.4 years with a standard deviation 2.66 (21.5 per cent of the mean) (see Table I). All the estates are in Tsing Yi District. In this study, the non-estate type housing accounts for about 30 per cent of the total sample. Such a district is ideally suited to the purpose of this research because it is a large residential area with a large number of transactions, households have similar levels, and variations in building qualities are small.

Table II presents the correlation matrix of the variables. It can be seen that the correlation between PRICE and AGE, CM is negative, and that between PRICE and AREA is positive. The authors assume that a household is making decisions based on multiple factors including: area and age of dwelling units; view; the accessibility to recreational facilities. The mean value of house prices in our sample is 1.55 million Hong Kong dollars with a standard deviation of 0.32 million (20.6 per cent of the mean). Thus, price difference is also small. The

Table I. Descriptive statistics

	Sample mean	Standard deviation	Maximum	Minimum
House price (million)	1.55	0.32	2.30	0.87
Area	544	93.8	825	370
Age	12.4	2.66	17.0	8.0

data are based on 139 actual transactions recorded between 1 January 1999 and 31 March 1999, obtained from a large brokerage firm. All data are selected from Class B units (40-70sq.m). The dependent variable is the transaction price (Hong Kong dollars), and the definition of various housing attributes is shown in Table III.

In such a hedonic price model, dummy variables are used in the analysis. The dummy-variable method is commonly used to deal with discontinuous factors, and the coefficients of the dummy variables measure differences in intercepts. In this case, physical condition was classified as either "good" or "bad"; and "available" or "not available", coded with a 1 (present) or 0 (absent). Favourable attributes include access to shopping centre and the presence of recreational facilities and car parks. A negative neighbourhood attribute is introduced – CMTY: view of cemetery, for the reasons outlined earlier. Thus, for a dwelling unit that possesses the characteristics of a cemetery view, the binary dummy variable is given the value of 1; otherwise the value is 0.

	A1	AGE	CM	CP	EST	SH	SP
Area	1	0.0159	0.0403	–0.1784	–0.0158	0.0624	0.0342
AGE	0.0159	1	0.0937	0.1196	–0.0533	–0.7714	0.0213
CM	0.0403	0.0937	1	0.0665	0.1107	–0.2711	–0.5008
CP	–0.1784	0.1196	0.0665	1	0.6007	–0.2453	–0.1328
EST	–0.0158	–0.0533	0.1107	0.6007	1	–0.0568	–0.2211
SH	0.0624	–0.7714	–0.2711	–0.2453	–0.0568	1	0.5414
SP	0.0342	0.0213	–0.5008	–0.1328	–0.2211	0.5414	1
PRICE	0.6404	–0.2699	–0.5240	0.0476	0.15082	0.2829	0.1356

Table II. Correlation matrix of variables

Short form	Explanatory variables (expected sign)	Definition of variables
PRICE	Price (dependent variable)	Price in HK$
AREA	Floor area (+)	Gross floor area in sq.ft
AGE	Age (–)	From occupation permit date to 1999 (number of years)
CARP	Availability of car park (+)	1 if it has a car park, 0 otherwise
SHOP	Availability of a shopping centre (+)	1 if it is within ten minutes walking distance to a shopping centre, 0 otherwise
SPORT	Availability of sport facilities (+)	1 if it is within ten minutes walking distance to sport facilities, 0 otherwise
CMTY	Cemetery view (–)	1 if availability of cemetery within view of property, 0 otherwise
EST	Estate type of housing units (+)	1 if it is estate type, 0 otherwise

Table III. List of variables and their definitions

In Hong Kong, an ideal measure of neighbourhood attributes should take account of the estate type of dwelling unit. Thus, we introduce a new dummy variable EST that represents "estate type of housing". The dummy variable takes on the value of "1" if it is estate type; and "0" otherwise.

For the purposes of this study, access to shopping centre and sports facilities is measured by their availabilities within a ten minutes walking distance. Here, the authors use the minimum required walking-distance time (measured in minutes) to represent the walking distance. In our survey, the measure was based on the shortest route. For example, the dummy variable takes on the value of 1 if the walking-distance time equals, or is less than, ten minutes; and 0 if the walking-distance time is more than ten minutes.

Empirical findings

The hedonic-price literature assumes that the house prices can be described by a vector of continuous and dummy variables, such that:

$$\log(\text{PRICE}) = \beta_0 + \beta_1 \log(\text{AREA}) + \beta_2 \log(\text{AGE}) + \beta_3 (\log(\text{AGE}))^2 + \beta_4 \text{CARP} + \beta_5 \text{SHOP} + \beta_6 \text{SPORT} + \beta_7 \text{CMTY} + \beta_8 \text{EST} + u \quad (1)$$

where β_0 is the constant, β_i (for $i = 1, 2, \ldots, 8$) are the regression coefficients, and u is a random element that reflects the unobserved variations in the house prices. The house price (PRICE), floor area (AREA) and age of the flats (AGE) are continuous variables while the other explanatory variables are dummy variables. Properties tend to be cheaper with increasing age: thus, squared-log(AGE) is introduced. The reason for the squared-log Age is that the effect of age may not be linear (i.e. increasing age may have a more or less than proportional change on price). Table III presents the exact definitions of the variables, along with a more detailed description of the data employed. Specifically, the associated estimators of the continuous variables represent the corresponding price elasticity.

Tests of the hedonic regression model (OLS1) are shown in Table IV (column 3). All the variables except SHOP are significant. The explanatory power of the model is close to 85 per cent of the variation in (log) house prices. Note that the explanatory power of the regression equation without the location variables (i.e. using only the area, age and car parking variables) decreases to 47 per cent (column 2 in Table IV). The coefficient associated with accessibility to car park (CARP) is highly significant, indicating that the car park-effect has a strong and positive influence on house prices. It is interesting to note that the positive effect of EST indicates that homebuyers strongly favour estate-type housing. The effect of "AGE" is also remarkable. As expected, the coefficient on log(AGE) is negative, whereas the coefficient on $\log(\text{AGE})^2$ is positive. Larger units are generally perceived to have higher prices. However, the valuation of larger units does not increase proportionately with its area. The coefficient on log(AREA) indicates that the log of each square foot increases the log of the price by 0.78 cents, not necessarily the same in percentage terms. Since house

	OLS	OLS1	OLS2	OLS3	WLS1	WLS2
Constant	***10.00	***14.96	***14.65	***14.47	***15.12	***14.68
	(18.89)	(11.07)	(5.92)	(8.29)	(10.23)	(9.65)
log(AREA)	***0.755	***0.779	***0.789	***0.783	***0.780	***0.784
	(9.75)	(17.19)	(17.48)	(18.03)	(17.96)	(17.39)
log(AGE)	***–3.18	***–4.34	**–3.85	***–4.05	***–4.47	***–4.15
	(–7.54)	(–4.51)	(–2.12)	(–3.06)	(–4.03)	(–3.66)
log(AGE)–squared	–	***0.806	*0.653	***0.763	***0.833	***0.769
		(4.12)	(1.89)	(2.88)	(3.65)	(3.30)
Car park	***0.288	***0.260	***0.187	***0.315	***0.261	***0.259
	(6.47)	(6.34)	(2.88)	(6.51)	(6.47)	(6.40)
Shopping centre	–	–0.052	***–0.223	–	–0.051	–0.047
		(–1.39)	(–3.48)		(–1.42)	(–1.33)
Sports centre	–	***–0.120	–	–0.144	***–0.122	***–0.119
		(–4.28)		(–5.45)	(–4.08)	(–4.01)
Cemetery view	–	***–0.381	***–0.343	***–0.387	***–0.381	***–0.382
		(–8.46)	(–15.72)	(–17.69)	(–14.23)	(–14.58)
Estate type	–	*0.045	**0.089	–	0.044	*0.047
		(1.70)	(2.27)		(1.54)	(1.70)
Adj. R^2	0.466	0.849	0.846	0.856	0.977	0.995
SSE	2.99	0.815	0.884	0.825	0.831	0.870
F-statistics	40.0	94.9	99.4	126.8	711.3	3432.1

Notes: *, ** and *** indicate significance at the 0.1, 0.05 and 0.01 levels. Figures in parenthesis are standard errors
WLS1: Weighted least square with log(AREA) containing the weights
WLS2: Weighted least square with log(AGE) containing the weights

Table IV.
Analysis of hedonic equations (dependent variable: log(PRICE))

prices in Hong Kong are expensive, the demand for small units is relatively greater in such medium quality housing.

The most striking feature of the results is that the coefficient of the dummy variable CMTY representing the presence of cemetery view is negative, and statistically significant (OLS1). This supports the previous argument that cemetery view is a negative housing attribute in Hong Kong. Note that poor quality estate housing may be built on land near to cemeteries, but most of them are public housing.

All the signs of coefficients are as expected except for SPORT. However, this does not indicate that "access to sport facilities" is inversely valued as a part of the attributes; since most large housing estates have their own clubhouse and sports facilities, its effect on house prices may have overlapped with the dummy variable EST. When the parameter SPORT was dropped, the coefficient on EST has shown a much higher significance level (OLS2 of Table IV). In hedonic studies, it is most common to omit or have inappropriate measures of neighbourhood characteristics. This is both because such data are more difficult to collect and because some of the variables tend to be correlated. If we dropped SHOP and EST, the coefficient on SPORT is still insignificant (OLS3 of Table IV). However, the coefficient on AGE increases from –4.34 (OLS1) to –3.85 (OLS2), and the coefficient on EST increases from 0.045 (OLS1)

to 0.089 (OLS2). By dropping SPORT, the effect of EST on house prices is more pronounced. It is interesting to note that the coefficients on AREA and cemetery view do not change significantly in both cases. In OLS1, the coefficient on SHOP is insignificant. However, by dropping SPORT, the coefficient on SHOP is negative, and becomes highly significant, because large shopping centres often create congestion and more environmental problems in residential areas. Thus, there is no surprise that residential property tends to be cheaper when it is close to the shopping area.

A potential difficulty in hedonic analysis is the presence of heteroscedasticity, i.e. observations on larger dwelling units tend to have larger error terms than do observations on small units. Another possible situation is that observations on older dwelling units tend to have larger error terms than do observations on new units. This will cause the estimates to be biased and inefficient (but it does not bias the estimates). One way to improve efficiency in the face of heteroscedasticity is to use a heteroscedasticity consistent covariance matrix estimator which provides correct estimates of the coefficient covariances in the presence of heteroscedasticity of unknown form (Andrews, 1991). In addition, a weighted least squares method can be used (Waddell *et al.*, 1996).

We now run the regression equation (1) using weighted least squares together with a heteroscedasticity consistent covariance matrix estimator. The estimation is completed by running a regression using the weighted dependent and independent variables to minimize the sum-of-squared residuals:

$$S(\beta) = \sum w_t^2 (y_t - x_t' \beta)^2 \tag{2}$$

with respect to the k-dimensional vector of parameters β, where y_t is a general function of the explanatory variables x_t, and w_t are the values of the weight series.

Table IV shows the results of the weighted least square. The weighted least square with log(AREA) containing the weights shows that the coefficients are very close to the model OLS1. However, the coefficient on EST becomes insignificant. When log(AGE) contains the weights, the coefficient on log(AGE) slightly increases from –4.34 (OLS1) to –4.15 (WLS2). However, the overall results are also close to the OLS1.

The results presented above have documented the importance of estate type and neighbourhood amenities in hedonic analysis of housing markets. Under the estimations obtained above, the value of estate type of housing will be reflected into the equilibrium house prices. In applying the hedonic technique and interpreting the values it may generate, it is however important not to forget the underlying assumptions. To the extent that one housing attribute is effectively correlated with other characteristics, the aggregate valuation of amenities will be biased. An important note is that the use of the hedonic estimation implicitly requires that relative prices among various housing attributes remain unchanged. In this case, it is necessary to control and account

for differences in housing attributes in order to estimate the house prices for a vector of varying housing bundles. In the presence of strong neighbourhood effect, one would have to use GIS co-ordinates to define position. Spatial correlation regression method can also be used. Accordingly, we have to account for variations in the overall price structure throughout all quality levels. It may be necessary to separate the hedonic regressions in order to allow for independent estimations of each housing attribute.

Conclusions

This study used a hedonic price methodology with transactions-based data to demonstrate that increases in house prices are strongly related to the estate-type of housing, based on a sample of residential developments of middle-income householders in the Tsing Yi district of Hong Kong. Our results show that estate-type dwelling units are valued by the homebuyers as attributes reflecting the preferred quality of a living environment. The fit of the equations was found to be very satisfactory as an adjusted R^2 higher than 0.85 was calculated. In addition, the paper demonstrated that the availability of car parks has a strong effect, which was capitalised into higher house prices. Using the weighted least square, it was found that the attribute of a cemetery view has a negative influence on house prices, when heteroscedasticity was corrected. However, the accessibility to a shopping centre is not a favourable housing attribute for small/medium units in determining house prices.

The housing market is an inherently dynamic, stochastic, multidimensional and an interdependent entity. For instance, rising income increases the demand for higher quality accommodation and environmental amenities. Recognition has to be given to changes in the price structure of the housing attributes when different housing characteristics are considered. In such analysis, it is often assumed that individuals have the same tastes and motives. To ascertain the quality of the market comparison approach in a formal appraisal, it is frequently necessary to assess the elements of comparison. Accurate estimates of appraised value can be useful in helping sellers set asking prices, in helping buyers set offering prices, and in bringing buyers and sellers together toward an agreed transaction price.

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