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An Empirical Study Investigating the Effects of Attributes on the Condominiums Price in Xi'an by Structural Equation Modeling

Ying Wang[1] and Mei-yung Leung[2] and Yong Zhou[3]

ABSTRACT

The price of a house has to compensate for its varied structural attributes, such as size, number of bathrooms, neighborhood condition, and construction quality. A large body of work has identified the effect of each attribute of the housing price using hedonic price theory. This paper focuses not only on the individual structural attributes, but also on the immeasurable integrated characteristics, such as characteristics of the location, characteristics of the site, characteristics of the building, and characteristics of the dwelling. The effects of these integrated characteristics on the price of condominiums in Xi'an, China have also been explored using the Structural Equation Modeling. The results from the empirical study showed that the location of houses/flats has the greatest effect on their price, and the neighborhood condition along with the district quality plays a more important role in determining the location value than the distance from the city center. The study also found that characteristics of the site and building, especially characteristics of the dwelling, have comparatively smaller effects on the price.

KEYWORDS

Housing price
Integrated characteristics
Condominium
Structural equation model
Location

[1]*Management School of Xi'an University of Architecture and Technology, Xi'an, China*
tel: (86) 029-82220382; email: haokey@hotmail.com.
[2]*Building and Construction Department of City University of Hong Kong, Kowloon, HK, China*
tel: (852) 27887142; email: bcmei@cityu.edu.hk.
[3]*Management School of Xi'an University of Architecture and Technology, Xi'an, China*
tel: (86) 029-85533649; email: wyzh2x@163.com.

INTRODUCTION

Residence is not only an everyday necessity; but also, in many economies, the most valuable asset owned by the households. Residential construction investment occupies a large share of fixed asset investment in an aggregate economy. In view of its important effects on the welfare of the individuals and the aggregate economy, economists have a great interest in, and have devoted considerable efforts to understanding, the structure of the demand for housing.

In this context, hedonic price theory has been extensively used. The theoretical foundation of this method was developed by Lancaster (1966) and Rosen (1974), and the first application of hedonic price theory in real estate research was made by Ridker and Hemming (1968). The hedonic price model attempts to solve the problem of heterogeneity by using an econometric model, which relates the price of a particular property to its characteristics, such as location, lot size, access to amenities and construction condition. The appeal of hedonic price model stems from the fact that they can be used to value specific aspects of a residential house as well as to forecast the price of a residential house with specific characteristics. But they are not limited to these applications. From the earliest work to the most recent studies, the standard approach to estimate the hedonic price function has long been the selection of a functional form in which its actual values is determined by a finite number of parameters. The estimation then proceeds by selecting those parameter values that result in a hedonic price function, which gives the "best fit" to the data. In addition to the linear or logarithmic parametric forms, since 1980, hedonic studies have been applying to more flexible functional forms obtained by applying the Box-Cox transformation.

No matter which function form is selected, it always establishes the relationship between a house's price and its individual structural characteristics. However, sometimes, we are interested not only in the effect of a bedroom, a bathroom, or other attributes on the price, but also in whether the integrated dwelling characteristics composing bedrooms, bathrooms, or other attributes are considered more important by the consumers, and that, therefore, has a greater effect on the price of the housing unit than the integrated location characteristics, which include access to amenities, public services, environmental quality, and so forth. Since the ordinary hedonic price function cannot achieve this objective, this paper introduces the adaptation of Structural Equation Modeling (SEM) to identify the relationship between the housing price and integrated characteristics. SEM is a multivariate statistical technique with less restrictive assumptions. It encompasses and extends regression, econometric, and factor analysis procedures (Bollen, 1989), and analyzes hypothesized relationships among latent (i.e. immeasurable) variables that are measured by the manifest (i.e. measurable) indicators. In addition, SEM has the advantage of simplifying a model. In the hedonic price function, there are many characteristics indicating different conditions and must therefore be dealt with as dummy variables – for instance, the type of heating; whether the building condition is good, fair, or poor; the date of sale; and so on – thus, large dummy variables will lead to a cumbersome and illegible model. In contrast, all values of a condition variable can be given to a variable, and the number of variables is reduced significantly in SEM. Thus, a more accurate estimation of parameters can be achieved with the same sample size limitation, since, all other things being equal, the more variables are included in a model, the greater the sample size is.

Since condominiums occupy the largest fraction of the housing market (above

90 percent) in China, they are the most representative buildings in the market. This paper, therefore, aims to: (1) give a brief overview of the residential market in Xi'an; (2) describe the frame and variables of the structural equation model and the data used in the study; and (3) report the results obtained from an empirical study.

OVERVIEW OF THE RESIDENTIAL REAL ESTATE MARKET IN XI'AN

Xi'an, the provincial capital of Shaanxi and the center of northwest China, is a large and historical city with an urban population of more than 3 millions. Despite this, Xi'an is a developing city, unlike those developed cities such as Beijing, Shanghai, and other southeast coastal cities. However, in recent years, under the implementation of the "Western China Development Strategy" and the expansion of the population base, the level of real estate activity in Xi'an has been greatly increased. More than one quarter of the total fixed asset investment is made up of real estate investment, of which residential investment represents a large share, approximately 80 percent, that represents an increase of more than 10 percent a year. On the other hand, demands for housing are brisk, with more than 2 million square meters being traded every year, which has 90 percent of real estate market sales volume. Xi'an city is divided into the following zones: City Central, City East, City South, City West, City North, City Gaoxin, and Xi'an Rural. With the exception of the rural zone, these city districts conduct real estate business. Hence, this paper has limited its research scope to these six zones.

RESEARCH MODEL

A full SEM consists of a structural model and a measurement model. This technique has been successfully applied in social science (Baumgartner and Homburg, 1996), psychology (Siguaw and Widing, 1994), and behavioral construction management (Leung et al., 2004) studies. This paper applied the SEM to real estate economics in order to explore the influence of the integrated characteristics of condominiums in the Xi'an housing market on the trading price. This aim is realized by LISREL program (Joreskog and Sorbom, 2001). The structural model in this study describes the relationships between price and integrated characteristics. Thus, price and integrated characteristics are latent variables: price is the endogenous and dependent variable, while integrated characteristics are the exogenous and independent variables. In contrast, the measurement model describes how each latent variable is measured by the corresponding manifest indicators.

The traded price of housing adjusted by the Consumer Price Index (CPI) can properly represent the latent variable PRICE, it is designated as the indicator of *price* named Priceaj. On the other hand, the other latent variables of integrated characteristics and their indicators in the model ought to be determined. The attributes influencing the housing price are categorized into four integrated characteristics, namely location characteristics, site characteristics, building characteristics and dwelling itself characteristics. In detail, location characteristics includes the district that the lot is located, the distance from the city center, and, the access to different facilities (e.g. jobs, shopping, transportation station and entertainment), the provision of local public services (e.g. education, fire, and police services), and the environmental quality (e.g. air pollution and noise level) (Dipasquale and Wheaton, 1996). A site consists of various characteristics such as lot size, total floor area, seller's credit condition and so on;

while the characteristics of a building include its height and its orientation (i.e. whether it is a pure residential building). On the other hand, the characteristics of dwelling refers to the number of bedrooms, the number of bathrooms and the area of floor. Hence, four latent variables are determined in the study, namely DWELLING, BUILDING, SITE, and LOCATION.

Although the integrated characteristics involve many items, as discussed above, some of them were selected to be the indicators of the integrated characteristics for the model's parsimony and estimation. For instance, the total number of rooms could not be considered due to the high correlation to the floor area, which may lead to estimations being inefficient (see Hoesli and Thion, 1995). In addition, the seller's credit condition has not been taken into consideration, as it has no direct causal connection to the value of the property (see Edmonds, 1984). The meaning and nature of these manifest variables are shown in Table 1.

Table 1 Definition of Variables in the Model

Latent Variables	Manifest Variables	
	Indicators	**Definition**
Endogenous variables:		
PRICE	Priceaj	Price of traded housing adjusted by CPI (in RMB per m^2, continuous variable).
Exogenous variables:		
DWELLING	Bedrooms	Number of bedrooms (ordinal variable).
	Bathrooms	Number of bathrooms (ordinal variable).
	Area	Floor area (in m^2, continuous variable).
BUILDING	Purelivi (1= otherwise; and 2= pure living building)	Is it a pure living building (ordinal variable).
	Height (1= less than 7 floor; 2= 7 to 12 floors; and 3= more than 12 floors)	Height of building (ordinal variable).
SITE	Lotsize	Lot size (in 10,000 m^2, continuous variable).
	Totaarea	Construction area on the lot (in 10,000 m^2, continuous variable).
	Totabuil	Number of buildings on the lot (continuous variable).
LOCATION	Neighborhood (1 to 5 indicates the condition from the worst to the best)	Comprehensive appraisal on the surrounding quality of natural and social environment within 1 kilometer radius (ordinal variable).
	Distance (1= outside the 2nd circuit road; 2= between the first and the 2nd circuit road; and 3= inside the 1st circuit road)	Distance from the lot to the center of the city (ordinal variable).
	District [1] (1= City North; 2= City West; 3= City East; 4= City South; 5= City Gaoxin; and 6= City Central)	Zone that the lot is located (ordinal variable).

Note: [1] – refer to a recent study conducted by the authors for ranking the quality of living environment among the regions in Xi, an, including City North, City West, City East, City South, City Gaoxin, and City Central (Huang, 2006).

Almost all indicators of the latent variables can be directly measured except Neighborhood which is an indicator of LOCATION variable. A simple questionnaire, therefore, is designed to measure Neighborhood indicator. This questionnaire includes 7 items, namely access to jobs, shopping, and entertainment; provision of education and medical services; air pollution condition; and noise level. The targeted respondents are residents within 1 kilometer-radius around sample flats. Over 10 questionnaires per flat were effectively returned. The interviewees were asked to rate each item using a scale between 1 and 5 in which 1 indicated "the worst" and 5 indicated "the best".

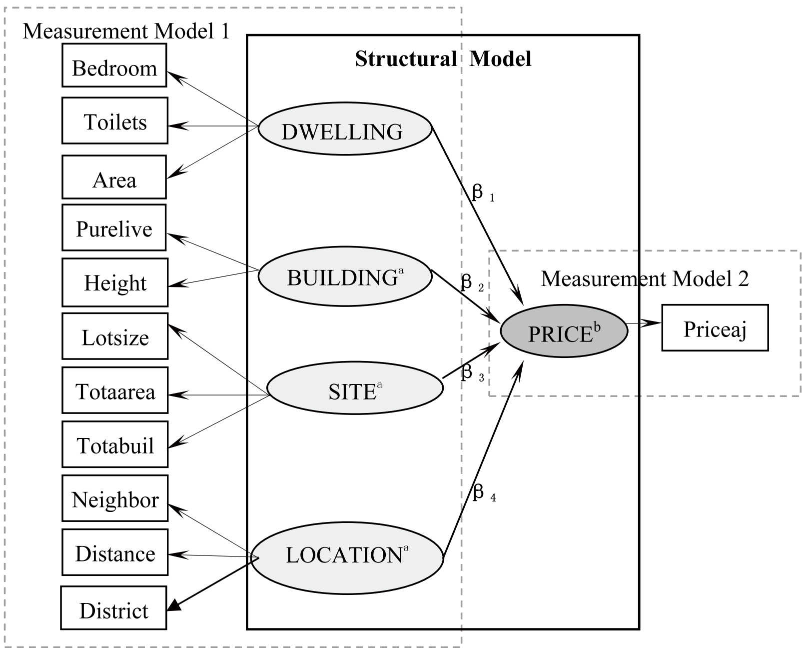
Based on the definition stated in Table 1, the relationships among all variables in the model are shown in Figure 1.

As shown in the above model, three sub-models are established. Measurement Model 1 expresses the relationship between four housing integrated characteristics and their indicators, while the Measurement Model 2 explains how the latent variable PRICE is identified. The third model establishes a Structural Model representing the causal relationships between the four Integrated Characteristics and the PRICE of housing. This paper identified the value of path parameters, β, to determine which integrated characteristic plays the most significant role in determining the housing price.

DATA

Transaction data of the Xi'an real estate market are not available to the public, and therefore

Figure 1 Structural Equation Model for Price



Note: [a] exogenous variable; [b] endogenous variable commercial banks were used as the data source of this study. Samples are often "cleaned up" using various procedures, such as the exclusion of certain data described as being unusually low or high. If such deviations are caused by measuring faults or errors in the data collection process, their elimination from the sample is uncontroversial. If, however, extreme values exist for a correctly documented regular sales procedure, cleaning up the sample is considered questionable (Raimond et al., 2004). In fact, the extreme values used here cannot be proved with any error; therefore, the application of general cleaning procedures has been avoided.

After excluding the transactions that are incomplete with regard to the relevant variables, the sample to be used in the following study was reduced to 1,560. Table 2 displays the summary statistics of variables.

EMPIRICAL RESULTS

Measurement Model Analysis

Ignoring measurement error may lead to inconsistent estimations and inaccurate assessments of the relationships between the underlying latent variables (Bollen, 1989). Therefore, the measurement properties (validities and reliabilities) of the measurement instruments need to be checked. Table 3 shows the estimation of the measurement model. The factor loadings, t-value, and squared multiple correlation (R^2) are all used to assess

Table 2 Descriptive Statistics for Manifest Variables

Variables	N	Mean	St. dev.	Min	Max	Skew	Kurtosis
Bedrooms	1560	2.58	0.612	1	4	0.044	-0.326
Bathrooms	1560	1.50	0.502	1	2	0.000	-2.026
Area	1560	116.93	27.65	47.00	194.00	0.183	-0.018
Height	1560	1.57	0.737	1	3	0.879	-0.628
Purelivi	1560	1.34	0.475	1	2	0.683	-1.55
Lotsize	1560	6.45	16.98	.20	38.00	5.38	4.77
Totaarea	1560	16.66	23.16	.75	52.00	4.50	3.62
Totabuil	1560	12.83	32.833	1	100.00	5.96	4.52
Neighborhood	1560	2.83	0.841	1	5	0.654	0.522
Distance	1560	2.54	0.626	1	3	-0.387	-0.160
District	1560	3.65	1.409	1	6	0.115	-0.981
Priceaj	1560	3121.86	522.541	1580	4500	-0.416	0.732

Table 3 Estimation of the Measurement Model

Latent variables	Indicators	Factor Loading	t-value	R^2
DWELLING	Bedrooms	0.99	16.72	0.98
	Bathrooms	0.85	12.99	0.73
	Area	0.95	15.58	0.90
BUILDING	Height	0.85	7.80	0.73
	Purelivi	-0.47	-5.19	0.22
SITE	Lotsize	1.00	17.32	1.00
	Totaarea	0.90	12.17	0.82
	Totabuil	0.85	10.25	0.72
LOCATION	Neighborhood	0.71	9.20	0.50
	Distance	0.40	4.76	0.23
	District	0.72	9.39	0.52
PRICE	Priceaj	1.00	17.32	1.00

the validities and reliabilities of measurement models. The factor loadings indicate validity coefficients, and R^2 is usually interpreted as the reliability of the measurement. During the measurement model testing, the factor loadings of all indicators were greater than 0.2, all R^2 values were greater than 0.20, and all t-values were greater than 1.96, and therefore they were considered to be good manifest variables of the latent variables (Joreskog and Sorbom, 2001).

Structural Model Analysis

The process of deriving the final structural model results involves parameter estimates, measures of overall fit, component fit measures, and the modification. Maximum likelihood (ML) is adopted to estimate the parameters.

Table 4 gives the ML estimators of the structural equation. The first line lists the parameter between the independent variables and the dependent variable, and below each parameter are its standard error and the relevant t-value. At the same time, R^2 for the structural equation is listed in the table. It can be seen that all the path parameters between PRICE and integrated characteristics are significant at the least level of 0.05 (dwelling, building, and site) and 0.001 (location) with an R^2 of 87.1 percent, which is within the acceptable range (see note[1] for other studies on the hedonic price model).

The goodness-of-fit indices of the model are shown in Table 5. The goodness-of-fit indices determine the degree to which the model as a whole is consistent with the empirical data in the study. Multiple criteria are therefore suggested, including degree of freedom (df), chi-square (χ^2), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), goodness-of-fit index (GFI), and adjusted goodness-of-fit index (AGFI) (Diamantopoulos and Siguaw, 2000; Bollen, 1989). It can be observed that all the goodness-of-fit indices are satisfactory[2].

It is utmost important that any modifications made to an original model are substantively meaningful and justifiable, because the evaluation of the model and the assessment of fit are not entirely a statistical matter (Diamantopoulos and Siguaw, 2000). Due to the good component fit testing and reasonable overall fit assessment, and as none of the modification information provided by the program offered a clear and well-founded interpretation, no further modification was implemented; the model was, therefore, proved by the data set at a certain statistical level.

1 Milton et al. (1984): 68%–76%; Rasmussen and Zuehlke (1990): 96.7%; Raimond, Martin, and Steffen (2004): 89.1%.

2 Good overall fitness standard is : $\chi 2/df<2$; CFI, IFI, GFI, AGFI$>$0.9; RMSEA, SRMR$<$0.05.
If 0.05$<$RMSEA$<$0.08, it indicates a reasonable fit (Diamantopoulos and Siguaw, 2000).

Table 4 Path Parameter (β) Estimates of the Model

Dependent variable	Independent Variables				R^2
	DWELLING	BUILDING	SITE	LOCATION	
PRICE	β_1=0.052* (0.026) 2.01	β_2=0.27* (0.11) 2.52	β_3=0.34* (0.13) 2.53	β_4=0.98*** (0.14) 7.11	0.87

Note: * p<0.05; *** p<0.001

Table 5 Goodness-of-fit Indices of the Model

χ^2	df	χ^2/df	RMSEA	SRMR	CFI	GFI	AGFI
0.34	46	1.96	0.059	0.049	0.97	0.96	0.93

DISCUSSION

The relative contribution of the integrated characteristics to the price is shown in Table 4. The structural equation model strongly indicates that LOCATION has the greatest effect on PRICE of traded condominiums among all factors (β_4=0.98). Location is always the focus of real estate research, in which immobility is the most basic and important feature of real estate goods. Thus, to some extent, it is fully consistent with the traditional urban economics theory: a central principal of urban economics is that the price of land will vary with the location (Balchin et al., 2000), and this varying land price affects the housing price. In addition, Neighborhood and District are better representatives of LOCATION than Distance (see Table 3). On the one hand, Xi'an has enjoyed a convenient traffic net and low transportation costs following the road construction in recent years, so the living area that people can select has expanded. On the other hand, following the establishment of technology development district, economy development district and ecological tourism district's one after another, new urban cores are forming continually. Thus, Xi'an is developing into a multi-centric and modern city: manufacturing sites, office sites, and living sites are scattered across every district, though with different densities, therefore, the distance from the city center influences fewer peoples' life. In contrast, residents concern more on the public service facilities and environment quality surrounding the flats. In addition, the result indicates that every district has its own distinguished features endowed by different historical backgrounds and urban plans, which has different influences on the housing price. For example, Gaoxin district and City South district are called the Central Life District. There are fewer factories, better education and cultural resources, thus, more residents, which results in a higher price.

SITE is the second most important factor affecting PRICE (β_3=0.34). As peoples' income increases, they demand more for the housing estate, for instance, it is better to have more grassland and more living services, such as sports ground, convenience store, beauty salon, nursery and primary school. The bigger the site is, the better the facilities are. Hence, the lot size, the number of buildings and the total area are all good representatives of SITE.

Finally, the characteristics of a dwelling play a relatively minor role in influencing the housing price (β_1=0.052), which indicates that the implicit prices of dwelling characteristics, including the number of bedrooms, the number of bathrooms, and the size of the floor area, are very small. This contrasts with the findings of other studies (Raimond, Martin, and Steffen, 2004; Ogwan* and Wang, 2003), but the conclusion that residents care less about dwelling characteristics is a difficult one to make. The dwelling facing south and a good spectacular view were rated to be more important than the number of bedrooms or bathrooms provided. However, we could not acquire such information from the current dataset. Therefore, the effects of the characteristics of a dwelling on the price should be further explored in further research.

CONCLUSION

Research on the implicit price of housing for discovering the preference of buyers is always an interesting topic for many economists. The ordinal method generally establishes the Hedonic Price Model to investigate the relationships between specific structural attributes and traded price of housing. However, this paper does not only focus on the individual structural attributes, but also on the effects of the integrated characteristics determined by these structural attributes on the housing price. Based on the housing economics literatures and theories, an empirical study was conducted in the Xi'an condominium market. The Structural Equation Modeling was introduced to identify the relationships between the price of a condominium and its integrated characteristics (i.e. dwelling, building, site and location). The results showed that the location of a flat is the first and prior element in determining its traded price. This does not only reflect that the consumers concern most on the location of a house when buying housing, but also confirm that location selection is very significant in housing project development. At the same time, the neighborhood condition and the district quality are also found to be more important in determining the location value than the distance from the city center does. It reflects that Xi'an is developing into a multi-centric modern city. The result is useful for us to realize the balancing city development. Better public facilities and good social and natural environment are important for improving the value of an area and absorbing the immigration and agglomeration of urban residents and firms. It definitely will boost the regional economy finally. However, the study also indicated that characteristics of site, building, and especially dwelling have a less important effects on the price. Thus, property developers should pay more attention on site selection and establish more living and entertainment facilities in the community.

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