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Application of the hedonic pricing model to real estate valuation in Hanoi, Vietnam

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Abstract

The value of real estate is determined by the relationship between supply and demand in the market, location, and the physical structure of the land and surrounding area. During the development of infrastructure in the capital area of Hanoi, Vietnam, changes have occurred that directly impact housing prices. This study applies the Hedonic pricing model and asking prices to predict the market value of real estate and establish the correlation between the factors affecting land prices in Hanoi in 2023 and 2024. The results show that six main factors influence real estate prices: area, number of bedrooms, proximity to the city center, type, amenities, and structure. Among these, proximity to the city center has a negative impact, while the remaining factors have a positive impact on housing prices in this area. Based on these results, participants in the real estate market can make accurate predictions about housing prices, and market regulators can gain a comprehensive view of this market, particularly the factors influencing housing prices.

Keywords: Real estate; Hedonic pricing model; Hanoi capital; Real estate market

1. Introduction

Across countries worldwide, a new and modern approach has emerged in determining real estate (RE) prices, involving mathematical tools to establish the relationship between attributes and RE prices. This approach has led to the development of the Hedonic pricing model, which uses regression models to quantify the impact of various factors on RE prices. Over the years, the Hedonic regression method has been widely applied in housing market research to assess the relationship between house prices and their characteristics. However, each RE has unique attributes under different conditions, making it impossible to establish an exhaustive list of attributes (O'Sullivan & Gibb, 2006). In developed industrial countries, housing is a significant component contributing to wealth and is also a major factor influencing household spending and savings (Case et al., 2004). Each house has its own attributes, such as transportation, amenities, structural features, neighborhood, and environment (Leong, 2003). When valuing a house, a set of inherent attributes, such as location, structure, or neighborhood, plays a crucial role, directly affecting the house price (Yoo & Kyriakidis, 2009).

In Vietnam, real estate is defined as an asset that includes land, buildings, constructions, and other assets attached to the land as prescribed by law. Therefore, determining RE prices essentially involves determining the value of the land and the associated assets, generally referred to as house pricing in this study. The real estate market is one of the key markets of the economy, as it relates directly to a large volume of assets in terms of scale, nature, and multifaceted value in the national economy. The housing market is the most significant part of the RE market.

Currently, methods for determining RE prices include the direct comparison method, the extraction method, the income method, the surplus method, and the coefficient-based land price adjustment method. These methods represent traditional approaches to RE valuation. The selection of a specific method depends on the intended use of the land parcel, the nature of the RE under consideration, the available asset data, market information about that asset type, and

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the expertise of the RE appraiser. Traditional methods for determining RE prices face challenges when there is a need to determine RE prices on a large scale or to evaluate prices over an extended period of time.

In Vietnam, housing demand is increasing, especially in urban areas such as Hanoi. This is due to a large number of inter-provincial migrants who tend to move to major cities, while available land is limited. Additionally, most Vietnamese people prefer owning a house rather than renting.

Given this context, it is essential to identify the factors influencing house prices in Hanoi, using the Hedonic regression method. Therefore, the objective of this study is to determine the factors affecting housing prices and subsequently provide predictions that can serve as a basis for developing specific land price tables in this locality.

2. Literature Review and Research Hypotheses

Globally, numerous studies have examined real estate (RE) prices and their relationship with RE characteristics, primarily based on the Hedonic model.

According to Malpezzi (1996), one of the fundamental methods is modeling house prices and rental rates within a simple supply-demand framework, focusing on income, population changes, non-economic determinants, and other supply conditions. However, Kim & Renaud (2009) argue that, broadly speaking, house prices are determined by supply and demand. Over time, technological changes have altered the traditional pricing model. Many researchers and developers have suggested that house prices are better explained by the utility function of each house (Malpezzi, 2002).

In general, according to various studies, there are three main determinants explaining the price variation model: structural attributes, locational attributes, and neighborhood attributes (Yusuf & Ismail, 2012).

Locational Attributes: Many researchers have noted that locational attributes, such as accessibility to the city center, have a direct impact on housing prices (Aluko, 2011; Leong, 2003). Some locational attributes have a positive impact, while others may negatively affect housing prices. For example, cemetery views may have a negative influence, but feng shui-related beliefs could increase house prices. Other locational attributes considered in various studies include proximity to workplaces, distance to schools, shopping centers, and recreational areas.

Structural Attributes: Numerous studies have shown that the number of rooms and bedrooms, the number of bathrooms, and floor area are positively related to the selling price of a house. This is because buyers are willing to pay more for space, especially functional space (Aluko, 2011; Leong, 2003). Researchers have also concluded that the age of the building is negatively related to RE prices. Additionally, lot size, basement, and garage significantly influence house prices (Leong, 2003).

Neighborhood Attributes: According to Raymond Y. C. Tse (2002) and Mihaescu & Hofe (2012), the importance of neighborhood attributes in the Hedonic Price Model (HPM) includes socio-economic variables (social class and occupation), the quality of local government or city services (schools, hospitals, places of worship), and external factors such as crime rates, traffic noise, and proximity to airports.

Most studies on RE pricing have been conducted using the Hedonic model and multivariate regression analysis. Essentially, Hedonic methods are suitable for evaluating the relationship between price and house characteristics under simple conditions.

Knight (2002) used a maximum likelihood model and information on price changes during a property's marketing period to examine the relationship between selling price and time on the market. He concluded that houses with significant price adjustments during market evaluation periods tend to have longer selling times and lower average selling prices after adjustments.

Babawale and Adewunmi (2011) studied the external factors affecting RE prices in Nigeria. The authors used factors such as distance to churches, workplaces, parking spaces, and the security environment. The applied model took the form: $P = \beta 0 + \beta jXj + \beta dXd + u$. The results indicated that proximity to churches negatively impacts RE value; the closer a property is to a church, the lower its value.

The Hedonic model is an open model, with variables collected depending on data availability and the research context. Some models focus primarily on property characteristics to determine RE prices (Hasan Selim, 2009). In a recent study

by Gabriel K.B. (2011), the Hedonic model was used to examine factors such as distance from RE to churches, workplaces, security, and parking. Regression results showed that proximity to churches had a negative impact on RE prices, with house prices increasing the farther they were from churches.

Based on the current literature, it can be recognized that house prices are often influenced by factors such as house size, type of house, house structure, number of bedrooms, number of bathrooms, proximity to the city center, accompanying amenities (such as hot tubs, swimming pools), and local facilities (such as parks, plazas, schools, shopping centers), all of which are included in this study. The study presents the summarized hypotheses in Table 1 as follows:

Table 1 Research Hypotheses

Research Hypotheses	Description of Hypotheses	Author/Source
H1: House size positively affects house price (SIZE)	Larger houses provide more spacious and comfortable living space for families, and can also be used for business or office purposes.	Selim (2009); Amenyah & Fletcher (2013); Shimizu (2014)
H2: Number of bedrooms positively affects house price (BEDROOMS)	Houses with more bedrooms often meet the needs of large families, providing private space for each family member. Moreover, they are convenient for hosting friends or relatives.	Cebula (2009); Selim (2009); Baek et al. (2019)
H3: Number of bathrooms positively affects house price (BATHROOMS)	The number of bathrooms meets the basic needs of families. This feature is essential in a house and is often considered important by potential buyers.	Cebula (2009); Raymond Y.C. Tse (2002); Leong (2003); Mihaescu & Hofe (2012)
H4: Proximity to the city center negatively affects house price (CITY_CENTER)	Houses farther from parks, plazas, schools, or shopping centers may hinder families in enjoying recreational activities, education, or shopping. Hence, houses located farther from the center are likely to have lower prices.	Selim (2009); Aluko (2011); Amenyah & Fletcher (2013); Yayar & Demir (2014)
H5: House type affects house price (TYPE)	House type is a key factor for buyers, which includes types such as street-front houses, alley houses, or houses with gardens that provide green space and enhance living quality. Houses with better street access tend to be more expensive.	Limsombunchai et al. (2004)
H6: Local amenities positively affect house price (AMENITIES)	Houses near parks, plazas, schools, or supermarkets provide convenience for families in terms of recreation, education, or shopping. Such houses are often more expensive.	Cebula (2008); Selim (2009); Amenyah & Fletcher (2013); Ndegwa (2018)
H7: Modern house structure positively affects house price (STRUCTURE)	Houses with modern, up-to-date structures tend to have higher value compared to those with outdated facilities that have been used for many years.	Cebula (2009); Leong (2003)

3. Research methodology and database

In this study, the author employs a three-stage approach: data mining, data filtering and cleaning, and finally using the Hedonic pricing model to assess the impact of various factors on housing prices in Hanoi. This model is used to measure the influence of attributes on the overall transaction price. Multiple regression analysis allows the determination of property value, among other variables, based on structural characteristics, neighborhood attributes, accessibility, and land use types (Malpezzi S., 2008).

The regression model used to determine urban land prices is a multivariate regression model with the general form as follows:

$$P_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + e_i$$

Where:
P_i: The dependent variable represents the land price in the iii-th observation.
$\beta 0$: The intercept of the model.
$X1, X2,\ldots,Xn$: The independent variables represent the factors affecting land prices.
$\beta 1, \beta 2,\ldots, \beta n$: The regression coefficients represent the magnitude of the impact of the corresponding factors on land prices.
ei: Random fluctuation or error value in the iii-th observation.

For analysis, the study employs the multivariate regression method (OLS) to determine the influence of independent variables on the dependent variable. Statistical testing of parameter estimates is conducted using standard errors, t-tests, F-tests, and R.

Based on the Hedonic pricing model and the previously developed hypotheses, the research model applied to the housing market is as follows:

$$GIA = \beta 0 + \beta 1\ AREA + \beta 2\ BEDROOMS + \beta 3\ BATHROOMS + \beta 4\ CITY\_CENTER + \beta 5\ TYPE + \beta 6\ AMENITIES + \beta 7\ STRUCTURE + \varepsilon$$

Where:
- Dependent variable (PRICE): Housing price (in billion per square meter).
- Independent variables:
AREA: House area (square meters).
BEDROOMS: Number of bedrooms.
BATHROOMS: Number of bathrooms.
CITY_CENTER: Proximity to the city center (km).
TYPE: Whether the house has street frontage (= 1 if yes, = 0 if no).
AMENITIES: Whether the house has local amenities such as parks, plazas, schools, or shopping centers (= 1 if yes, = 0 if no).
STRUCTURE: Whether the house has a modern structure (= 1 if yes, = 0 if no).
ε: Error term (5%); βi: Coefficient; $\beta 0$: Constant.

Currently, information on housing prices is limited because real estate trading platforms or real estate associations do not easily provide data; the information is either confidential or, if available, incomplete for analysis. Therefore, researchers have sought alternative information by using advertised or asking prices (Ko K, Cao XJ., 2013; 2005). Most real estate listings have transitioned from newspapers to online advertising on websites specializing in the sale and rental of various types of houses and land. A large real estate database is advertised daily with useful information on these websites. This vast data source is used to assess housing prices by applying web scraping techniques (Boeing G, Waddell P., 2017).

Although asking prices may be limited in number, they are advertised across many media outlets, making them easily accessible to potential buyers or renters in the real estate market. Using these prices may lead to discrepancies, as the asking price does not always match the contract price. However, some researchers have pointed out that asking prices can also be used to analyze real estate and predict the market (Rodríguez DA, Targa F., 2004; Deng T, Ma M, Nelson JD., 2016) and are therefore used in many property-related studies. These types of datasets are publicly available on websites, enabling better urban and traffic planning, eliminating subjectivity in data collection from personal interests (Batty M, Axhausen KW, Giannotti F, Pozdnoukhov A, Bazzani A, Wachowicz M, et al., 2012).

The study collected survey data from 195 houses from two online real estate markets, chotot.com and batdongsan.com.vn, in Hanoi from October 2023 to February 2024. These are advertised prices, which may differ from transaction prices. Attributes collected include property price, area, number of bedrooms, whether newly built or old, etc.

4. Results and Analysis

First, the paper analyzes the correlation between the variables. The results are presented in Table 2 as follows:

Table 2 Correlation Between Variables

	Area	**Dien Tich**	**Bedrooms**	**Bathrooms**	**Centre**	**Type**	**Amenities**	**Structure**
AREA	1.000							
DIENTICH	0.128	1.000						
BEDROOMS	0.776	0.146	1.000					
BATHROOMS	0.546	0.167	0.656	1.000				
CENTER	-0.590	0.010	-0.473	-0.369	1.000			
TYPE	0.595	-0.046	0.429	0.315	-0.300	1.000		
AMENITIES	0.776	0.082	0.471	0.334	-0.413	0.615	1.000	
STRUCTURE	0.712	-0.092	0.536	0.370	-0.422	0.435	0.661	1.000

Table 2 shows that the distance from the house to the center (CENTER) is negatively correlated with its price (PRICE) while the other independent variables are positively related to the house price (PRICE).

Table 3 Tests for Multicollinearity and Heteroskedasticity

Multicollinearity Test		**Autocorrelation Test**
Variable	VIF	
AREA	2.52	Prob>chi2 = 0.000***
DIENTICH	2.36	
BEDROOMS	2.18	
BATHROOMS	1.79	
CENTER	1.73	
TYPE	1.41	
AMENITIES	1.14	
Mean VIF = 1.77		

*** significance level at 1%.

According to Table 3, the model is considered to have no serious multicollinearity issues. (Mean VIF = 1,77<10).

From Table 4, the estimation results are significant at the 1% level (Prob > F = 0.000). Specifically, the independent variables account for 85.59% of the variability in housing prices. Thus, the independent variables explain 85.59% of the variation in the price variable, while the remaining 14.41% is explained by factors outside the model and random errors. It can be concluded that the model is well-fitting and has practical applicability.

Table 4 Estimation Results

Dependent variable: House price (PRICE)		
Variables	Coef.	P>|z|
Constant	17.093***	0.000
AREA	0.001**	0.023
DIENTICH	0.065***	0.000
BEDROOMS	0.003	0.640
BATHROOMS	-0.020***	0.000
CENTER	0.148**	0.036
TYPE	0.087***	0.000
AMENITIES	0.050***	0.000
Number of obs	195	
R-squared	85.59%	
Significance level	F(8, 196) = 276.08 Prob>F = 0.000***	

Specifically, CITY_CENTER has a negative impact (β = -0.020) on PRICE at the 1% significance level, while PRICE is positively influenced by AREA (β = 0.001, at the 5% significance level), BEDROOMS (β = 0.065, at the 1% significance level), TYPE (β = 0.148, at the 5% significance level), AMENITIES (β = 0.087, at the 1% significance level), and STRUCTURE (β = 0.050, at the 1% significance level). However, the study did not find a significant effect of BATHROOMS on PRICE. Therefore, the estimated model has the following equation:

$$PRICE = 17.093 + 0.001\ AREA + 0.065\ BEDROOMS - 0.020\ CITY\_CENTER + 0.148\ TYPE + 0.087\ AMENITIES + 0.050\ STRUCTURE + \varepsilon$$

Effect of house size (AREA) on housing price (PRICE): The results show a positive impact on PRICE. This indicates that houses with larger areas tend to have higher prices. This result is consistent with the findings of Yayar and Demir (2014). Accordingly, larger houses meet the needs of large families, providing more spacious and comfortable living spaces. These houses can also be used specifically for business or office purposes.

Effect of the number of bedrooms (BEDROOMS) on housing price (PRICE): The results indicate that BEDROOMS positively affect PRICE. This is consistent with the findings of Selim (2009). Accordingly, houses with more bedrooms are suitable for families with multiple members. These houses also allow for hosting guests.

Effect of house location (CITY_CENTER) on housing price (PRICE): The results indicate a negative effect of CITY_CENTER on PRICE. This suggests that houses farther from the city center may be sold at lower prices compared to those closer to the center. This is due to the difficulty residents face in commuting to work or downtown areas, as well as the limited availability of public amenities compared to the latter. This finding is consistent with the studies of Selim (2009) and Yayar and Demir (2014).

Effect of house type (TYPE) on housing price (PRICE): The results show that PRICE is positively affected by TYPE. In densely populated urban areas, houses with street frontage or located on main roads have higher prices compared to those in alleys or narrow streets. This is consistent with Selim (2009)'s findings.

Effect of local amenities (AMENITIES) on housing price (PRICE): The study finds a positive effect of amenities such as parks on PRICE. Houses near parks, plazas, schools, or shopping centers are more desirable due to their convenience for recreation, learning, or shopping, and are therefore sold at higher values. This finding is consistent with those of Cebula (2009) and Selim (2009).

Effect of house structure (STRUCTURE) on housing price (PRICE): The study finds that PRICE is positively affected by STRUCTURE. This result was also found in the analysis of Cebula (2009). Newly built houses with modern architecture and design are more desirable and fetch higher prices.

5. Conclusion

This study shows that, in Hanoi, Vietnam, proximity to the city center negatively affects housing prices. Meanwhile, houses with larger areas, modern structures, more bedrooms, gardens, and local amenities (such as plazas, parks, schools, and shopping centers) have higher values. Based on these findings, participants in the housing market can make accurate predictions about housing prices, and housing market regulators can gain a comprehensive view of the market, particularly regarding the factors affecting housing prices. This is essential and serves as a basis for proposing appropriate solutions to promote an effective and sustainable housing market. Furthermore, these findings can be widely applied by appraisers at low cost, while developers can highlight high-value houses that meet customer needs. For distributors, it facilitates the improvement of distribution channels, allowing their projects to be quickly and effectively introduced to customers. The results also allow buyers to easily determine the true value of a house. Despite achieving its objectives, the study has its own limitations as it does not analyze other determinants that may affect housing prices, such as macroeconomic factors, developer reputation, and the effectiveness of housing distribution channels.

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