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## Hedonic Pricing Model for Housing Market in City of Kunming, the People's Republic of China

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# Hedonic Pricing Model for Housing Market in City of Kunming, the People's Republic of China

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## บทคัดย่อ

**ห** านที่อยู่อาศัยนับได้ว่าเป็นส่วนประภูมิที่จำเป็นของความมั่งคั่งของครัวเรือน การลงทุนในที่อยู่อาศัยนับได้ว่าเป็นตัวคัดชั้นที่สำคัญในทางเศรษฐศาสตร์มหภาคและความมีเสถียรภาพทางการเงินของประเทศ การศึกษานี้มุ่งจะศึกษาถึงตลาดที่อยู่อาศัยในเมือง Kunming ประเทศจีน โดยมีวัตถุประสงค์หลักคือเพื่อค้นหาลักษณะของที่อยู่อาศัยที่จะส่งผลต่อราคาที่อยู่อาศัยและเพื่อวิเคราะห์ว่าคุณลักษณะค่าใช้จ่ายที่อยู่อาศัยมากน้อยเท่าใดโดยใช้แบบจำลองเชิงเศรษฐศาสตร์ โมเดลเชิงเป็นแบบจำลองที่อธิบายว่าราคาของที่อยู่อาศัยจะถูกกำหนดโดยลักษณะของที่อยู่อาศัยซึ่งจะจำแนกโดยสถานที่ตั้งของที่อยู่อาศัย โครงสร้างของที่อยู่อาศัย และสภาพแวดล้อมของที่อยู่อาศัย

รูปแบบการกำหนดราคาความซ่อนจะใช้ในการตรวจสอบผลกระทบของลักษณะที่อยู่อาศัยในราคา การศึกษารั้งนี้นำมาใช้ 3 รูปแบบการทำงาน : เชิงเส้นให้เข้าสู่ระบบเข้าสู่ระบบและเข้าสู่ระบบ กึ่งรูปแบบการทำงานเพื่อคำนวณการกับ 204 ตัวอย่างในปี 2009 ผลการศึกษาพบว่ากลุ่มตัวอย่างพักอาศัยในคอนโดมิเนียมมีจำนวนสมาชิกในครัวเรือนเฉลี่ย 3 คน หัวหน้าครัวเรือนส่วนใหญ่ทำงานให้รัฐบาล ส่วนใหญ่จบปริญญาตรี ผลการศึกษาจากแบบจำลองเชิงเศรษฐศาสตร์ โมเดลพบว่าพื้นที่อยู่อาศัยซึ่งเป็นตัวแปรในลักษณะโครงสร้างของที่อยู่อาศัย และระยะทางที่อยู่ห่างจากศูนย์กลางธุรกิจซึ่งเป็นตัวแปรในลักษณะสถานที่ตั้งจะส่งผลต่อราคาของที่อยู่อาศัยอย่างมีนัยยะสำคัญทางสถิติ ส่วนตัวแปรอื่นในส่วนของสภาพแวดล้อมจะมีระดับนัยยะสำคัญต่อราคาที่อยู่อาศัยน้อยกว่าตัวแปรด้านสถานที่ตั้งและโครงสร้าง

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**คำสำคัญ :** ราคาที่อยู่อาศัย, ลักษณะที่อยู่อาศัย, แบบจำลองไฮโคนิกไพร์สชิงโมเดล, เมือง Kunming ประเทศจีน

## ABSTRACT

The main objectives of this study are to find the housing characteristics that significantly impact on housing price in city of Kunming in China by applying the hedonic pricing model. The hedonic pricing model assumes that the housing price is determined by housing characteristics that normally can be classified into locational attributes, structural attributes, and the neighborhood attributes.

The hedonic pricing model is used to examine the effect of housing characteristics on the price. This study applied 3 functional forms: linear, log-log, and semi-log functional form to conduct the model with 204 samples in 2009, the results of all three regressions can be found that R square and adjusted R square all very high close to 1, which indicates that the goodness of fit of the model is very well. The coefficients of all the variables which entered the model have same sign as expected by the hypotheses. The result showed that the housing price in Kunming was positively related to traffic condition, floor area, structural quality, inner and outer environment of the communities. However, the price was negatively distance to the central business district, housing age, total distance to nearest life establishments, educational services and entertainment facilities. Overall, the floor area of housing units and distance to Central Business District (CBD) are mostly significant by all three functional forms, they take the first and second place in significance on effecting housing price, respectively. The characteristics which belong to the neighborhood attributes are relatively less significant compare with the locational and structural attributes.

**Keywords:** Housing Price, Housing Characteristics, Hedonic pricing model, city of Kunming in China

## 1. INTRODUCTION

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Housing is an essential component of household wealth worldwide, the investment in housing have always been a major investment in people's lives. Compare with the capitalist countries, China's housing market situation is special and unique. China's housing market operates under a socialist land public ownership system together with the large population and scarcity of the residential land resource, the most prevalent housing type in China is the condominium which the households live together in one building by holding the self-ownership of each housing unit to share a piece of land within a community.

China's housing distribution program has been cancelled by the government since 1998 (Jianping Ye, 2001). Meanwhile, the real estate market has been going through commercialized reform and is developing at a rapid pace. This plays an important role in the civil economy and has become a hot spot of consumption within the new economic boom. The rapid development of an estate industry contributes to the promotion of other related industries and to the boom of economy. There is no doubt that the housing industry is gradually becoming the precursor and mainstay industry in China. The price of housing rises continuously with the development of the housing market in China, especially in the recent years. This attracts the attention and concern from many sectors such as government, enterprise, and expertise within the field, mass media and the ordinary people.

Due to the special geographical location and the advantages of abundant natural resources in southwest of China, the city of Kunming was developed an excellent local consumer market with its mildest climate in the region, it has become the political, economic, communications and cultural center in Yunnan province in southwestern China (Willy Schmid, et al. 1997). With the rising numbers of the residents in Kunming, the dramatically increase of the housing price has drawn more and more attention recent years.

This study focused on the housing market in urban area of Kunming which covers 6,200 square kilometers, applied the hedonic pricing model. The most predominant housing type in Kunming is the condominium which the households live together in one building by owning individual housing unit to share the public green space and facilities in such community. Due to the housing transactions were relatively active in 2009, the transacted price relative stable during this period. This study selects the sample housing units from the condominiums which transacted during 2009 as the cross-section data, this study aim to answer the following research questions:

- 1) Which characteristics of the housing units determine the housing price in Kunming?
- 2) How do these characteristics impact on the housing price in Kunming? Which characteristic is most significant for the housing price in Kunming?

## 2. THEORY AND LITERATURE REVIEW

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### 2.1 The theoretical framework

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The hedonic pricing theory applied into housing market can be derived from Alonso's theoretical framework which is considered as a basic foundation in modern housing theory. Lancaster proposed a new approach later to research on the products. Then Rosen combined with Lancaster's new approach to discuss the hedonic model from both the consumer's and producer's side. The basic consumer theory posed that consumers pursue the utility maximization of the goods while sellers seek the profit maximization. The market price of the goods exists when consumers' willingness to pay (WTP) agrees with the producer's willingness to accept (WTA), the market at an equilibrium.

Alonso (1964)'s theory focused on the land market which assumes that the housing unit is a homogeneous product. Alonso considered that the differences of the housing price primarily attribute to the distance from the city center. Like the traditional consumer theory, household investments of location and consumption bundles are described by the utility maximization model. In Alonso's framework, the household was regarded as an individual, who has a certain disposal income that he may spend between land and other goods. The location of the land refers to the services consumed after paying for commuting costs for the distance from the city center.

It can be concluded from the Alonso's traditional consumer theory that the price of land increases or decreases with the distance from the center place and declines at a diminishing rate due to the diminishing rate of substitution between the housing unit and the composite goods. The competition for central location will bid up the price of sites located closer to the center business district (CBD).

Kelvin J. Lancaster (1966) posed a new approach to consumer theory based on the traditional approach. The traditional theory states that goods are the direct objects of utility and goods are consumed only because that they are goods. In other words, goods

are just thought as items. The new approach posed that the utility is derived from the characteristics of the goods. A good is combined of numerous characteristics, and other products may share each of these characteristics. It assumes that consumption, singly or in combination, are inputs and the output is a collection of characteristics. The price of a product is constituted by the characteristics of that product.

The essence of the new approach can be summarized as follow three points:

- 1) The good, *per se*, does not give utility to the consumer; it possesses characteristics, and these characteristics give rise to utility.
- 2) In general, a good will possess more than one characteristic, and many characteristics will be shared by more than one good.
- 3) Goods in combination may possess characteristics different from those pertaining to the goods separately.

Rosen's (1974) theory combined the Lancaster's new approach with the utility and competition theory which apply to the heterogeneous product market, claimed that housing prices are determined by combination of numerous attributes of the housing units. In the market, consumers would like to maximize the utility of the product while producers plan to get the profit maximization, respectively. When the price of consumers' willingness to pay (WTP) agrees with the producer's willingness to accept (WTA), the market is at an equilibrium price. Towards both consumers and sellers, this price is the sum price of housing attributes due to each housing characteristics has its own implicit price. Rosen measured the amount of the  $n$  th characteristics exhibited in each goods, where  $z_n$  is represented by a real-valued vector  $Z = (Z_1, Z_2, \dots, Z_n)$ . In particular, a price  $p(z) = p(Z_1, Z_2, \dots, Z_n)$  is defined at each point on the plane and guides both consumers and producers on the locational choices regarding packages of characteristics bought and sold.

In Rosen's (1974) derivation of the hedonic function, it can be summarized that while the consumers pursue the utility maximization, the producers also seek for the profit maximization, and the housing price is the sum of each characteristic parameter multiplies their implicit price separately.

Overall, the hedonic pricing model postulates that a commodity is considered as an aggregation of individual components or attributes, the price of a marketed good derived from its value of the related characteristics, or services it provides. The value of these

characteristics normally cannot be observed directly, but which has a great contribute to market price of a commodity. In the housing market, the housing price is determined by the locational attributes, structural attributes and the neighborhood attributes.

## 2.2 LITERATURE REVIEW

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Housing has always been an eternal topic of concern for human being in the world. There are many studies that relate to the housing market using the hedonic pricing model, which cover both developing and developed countries as follows:

Hai-zhen Wen et al. (2005) analyzed the housing price that depended on housing characteristics divided into structure, neighborhood, location side by hedonic pricing model. This study selected 18 housing characteristics as the independent variables, and adopts the linear functional form to conduct the hedonic price model for the housing market in Hangzhou. The model was tested with 2473 housing samples and field survey data of 290 housing communities. As far as the whole housing market of Hangzhou is concerned, there are 14 housing characteristics with different influence degrees on housing price are significant, which are arranged sequentially from great to small: floor area, distance to West Lake, inner environment, distance to Central Business District (CBD), traffic condition, garage, attic, decoration degree, environment, community management, housing story, entertainment facility, transaction time, university nearby. Whereas, the housing age, orientation, life establishment and educational establishment are not significant. In conclusion, the contribution rate of effecting on housing price of architecture characteristic, neighborhood characteristic, location characteristic and other characteristic were respectively 60.0%, 16.5%, 19.8%, 2.7% for the standard housing units. Thus the structural characteristic is identified as the highest impacting factor in this study, and which indicates that the hedonic model can be applied and performs well in Chinese residential housing market.

Linshi (2005) based on the preference of households, selected 17 key variables of the housing market in Stellenbosch, South Africa. Of which 3 are continuous: housing price, size of plot and overall size of building; 3 are discrete: number of bedrooms, number of bathrooms and garages; 11 are dummy variables: 9 related to the housing locations and the rest two variables identified the swimming pool availability and alarm availability. The data derived from 220 single-family residential houses transacted in Stellenbosch during the year of 2002 and 2003, and 2004.

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The results of regression showed that size of building, the number of bedrooms and number of bathrooms, amount of garages spaces, availability of a swimming pool and availability of an alarm system are significant determinants which positively contribute to the residential housing prices in Stellenbosch. There are 6 locational dummy variables that are significant and negative in assessing the residential house price, indicating that the price of a residential house located at such area is lower than one which is in the center of town. The result also shows that, the availability of a swimming pool or alarm system has a significantly positive relationship with the residential housing price in Stellenbosch. In Andres Jauregui (2006)'s essay, the study focused on seven major metropolitan statistical areas (MSA) in Ohio: Akron, Cincinnati, Cleveland, Columbus, Dayton, Toledo, and Youngstown, selected 36 characteristics which related to housing price as independent variables by applying hedonic pricing model.

The result shows that the increasing number of rooms, size of house and lot size, as well as the number of full and half bathrooms has a positive impact on house prices. Houses with garages and pools also have higher selling prices. Housing age has a negative impact on house prices. The distance from the closest hazard variable is positive and significant in all areas, while the square of such distance is negative. Housing price increases at a decreasing rate of distance to the source of environmental risk, so the residents prefer a good environment quality around the condominium. The total emissions in air which from all industries are significant in just three areas, it is not a consistent in this study.

Monika Bazyl (2009) measured the impact of certain location characteristics on housing prices by applying the hedonic pricing model in the Warsaw housing market. Altogether there were 2300 observations. According to the estimation based on the hedonic pricing model, the results show that green areas increase flat price if they are within one kilometer distance. New metro stations increase prices of flats if they are located within one kilometer distance. The industrial areas decrease the prices of flats if they located within one kilometer distance. That is the price of a flat depends on its characteristics as it was assumed in the hedonic pricing model, yet it is not influenced by the neighboring flats. However, these are 'implicit prices' which do not explicitly account on the flat prices. Chihiro Shimizu et al. (2010) applied several variations of the Hedonic Model in their study. The observation data consist of 211,179 samples collected between January 1986 and September 2006. On estimated characteristics, the signs of each coefficient turn out to be the same and the results are quite similar as the previous studies.

Among the property characteristics specific to condominiums, FS (floor space), BS (balcony space), and NU (number of room units) have positive values. Age (age of building), TS (time to nearest station), and TT (travel time to CBD) have the negative values. First, regarding FS, the unit price was shown to increase with increasing floor space, consumers have a strong preference on the floor space of the entire condominium. A similar tendency was observed for BS and NU. As age increases, there is deterioration on the housing quality compared with the improvement of facilities in newer condominiums. The independent variable TS (time to nearest station) and TT (travel time to CBD) increase, there is a decrease on the convenience because of the greater distance from populated and flourishing areas, which result in a decrease in housing price.

### 3. RESEARCH METHODS

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#### 3.1 THE HEDONIC PRICING THEORY

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Hedonic method (utility valuation method) has been applied to build the housing price index for a long time. Court was considered the first to make the formal contributions to hedonic price theory in 1941, although some other informal studies have been performed. From the word meaning, the term "hedonics" is derived from the Greek word hedonikos, which simply means pleasure. In the economic context, it relate to the utility of consumers get from the goods and services.

The hedonic model based on the property values which involve a two stage estimation process. The first stage relies on the relationship between property value and the characteristics of properties. And the second stage is the estimation of the demand functions by utilizing the marginal prices obtained from the first stage hedonic price function. The parameters got from the demand estimation can then used in the welfare measure calculation.

The applications of the hedonic pricing model are based on some assumptions:

- 1) The goods are heterogeneous, each of which is combined with a bundle of the different characteristics
- 2) The market operates under a perfect competition market, there are numerous buyers and sellers, in which the impact from individual can be ignored.
- 3) Buyers and sellers have the perfect information on the goods

4) Market is at equilibrium, there are no inter-correlations between each of the characteristics.

Typically, the housing attributes are classified into locational attribute ( $L$ ), structural attribute ( $S$ ), and neighborhood attribute ( $N$ ). And each attribute encompass the related characteristics of the property, which measured both in quantitative and qualitative method (Chin Tung Leong 2003).

The function of the market prices ( $P$ ) of the property, therefore, can be expressed as:

$$P = f(L_i, S_j, N_k) \quad (1)$$

Where,

$P$  is the market price of the property  
 $L_i$  is the locational attributes  $i$  of the housing  
 $S_j$  is the structural attributes  $j$  of the housing  
 $N_k$  is the neighborhood attributes  $k$  of the housing

The partial derivative of the above hedonic function with respect to each attribute is the implicit marginal attribute price; *ceteris paribus* (Rosen, 1974).

According to the hedonic model, the basic function form can be written as:

$$P = \sum_{i=1}^l P_i^L L_i + \sum_{j=1}^n P_j^S S_j + \sum_{k=1}^m P_k^N N_k \quad (2)$$

The market price of the housing considered as the dependent variable which depends on the bundle of the characteristics refers to the location, structure, and neighborhood attribute of the housing units.

### 3.2 THE FUNCTIONAL FORM OF HEDONIC PRICING MODEL

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The application of the hedonic pricing model refers to the selection of the functional forms. Generally, there are three kinds of functional forms can be applied into the hedonic pricing model.

The linear function form is the most simple and direct one, it represents that one unit change in each characteristic will cause the change of housing price by such characteristic. The double-log form is one of the common functional forms. All the variables are the log form in the function, the regression coefficient correspond to the elasticity of the characteristic price. *Ceteris paribus*, one percent change in one characteristic will cause the percentage change of the housing price by this characteristic. The semi-log functional form is a variant of the double-log equation in which some but not all of the variables (dependent and independent) are expressed in terms of their natural log. The application of the semi-log form is quite frequent in economics and business. The right side of the equation (independent of the variables) is the linear form, and left side (dependent variable) is the log form, the regression coefficient correspond to the increasing rate change of the characteristic price by per unit change of the characteristic.

### 3.3 SELECTION OF THE VARIABLES

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Location is always considered as a pivotal housing attribute, it direct determine the accessibility to CBD and traffic condition of the housing unit.

Centre Business District (CBD) is the core of a city, the concentration of a city's economic, technological and cultural forces, along with the perfect municipal transportsations and communications system. The accessibility to CBD is measured by the housing distance to CBD (Andres Jauregui, 2006). The public bus transportation system is convenient in Kunming, the local bus route services cover the whole urban area of Kunming with nearly 200 bus routes at an economical price. The number of bus routes nearby is considered as an indicator of traffic convenience of a housing unit. The closer to the bus station and more choice of the bus routes, the more valuable of the housing unit.

The structural attributes refer to characteristics of floor area, garage, water or air heating system/fireplaces, cooling systems/ central air conditioning, structural quality of the housing unit, age of the building and the housing orientation. Of which, garage is not applicable

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for the condominiums due to it is normally not including in the selling price of housing unit. Water or air heating system/fireplaces, cooling systems/central air conditioning are not applicable because of the mildest climate in city of Kunming.

Floor area ( $m^2$ ) of the housing units directly determines the living space of a household and has an influence on the number of rooms in a housing unit as well. The floor level of the housing units was concerned by households with quite different preference. The height of condominiums is relatively homogenous that mostly has 7 stories. Structural quality of the housing units is usually refers to three factors of housing units: design, materials, and fixture. Orientation of the housing units has an effect on the amount of nature lighting of the housing unit. Households normally have a great preference on the housing unit with south-facing orientation (Haizhen Wen et al., 2005) due to it is warmer in winter compare with the housing units with other directional orientation. Culturally, this preference is influenced by the historical arrangement that the seating and living rooms of most Chinese emperors being of southern orientation in ancient China. The housing age has a direct influence on housing tenure of use (Chihiro Shimizu, et al., 2010), the older the housing unit, the more frequent incurring a housing repair.

The neighborhood attributes of housing units relate to the socio-economic status of neighbors, the environment quality around and inside the communities, the proximity to the educational services, life establishments, entertainment facilities and places of worship. The socio-economic status of real neighbors is not concerned by the households due to the unpredictability. The places of worship refer to mosques, churches, temples for religious activities, however, with the modern social trends, religious activity is less frequently encouraged by households in many modern cities.

The externality of environmental quality around communities refers to the crime rate, noise, and pollution. The inner environmental quality evaluate by the combination of public green space, security and cleanliness in the community. Proximity to the life establishments (e.g. the supermarket, restaurant, bank, post office) has a direct influence on convenience of households' daily life. Education is considered as a crucial part in one's life, thus it is of concern to most of households, especially households with children. The accessibility to entertainment destinations (e.g. park, cinema, gymnasium, and museum) is concerned by households because leisure is an indispensable part of household's life.

This study selects the 12 housing characteristics as the independent variables measured in quantitative and qualitative methods. The measurement of these characteristics and the expect sign of the relationship between the housing price and these characteristics are list as table 1.

**Table 1 The measurement of characteristics and the expected sign with the housing price**

	<b>Characteristic Variable</b>	<b>Measurement</b>	<b>Sign</b>
Location Attributes	Distance to CBD (Z1)	The linear distance to Central Business District (CBD) is approximately scaled by each 500 meters in Kunming	-
	Traffic condition(Z2)	The total number of the bus routes within 500 meters around the communities	+
Structure Attributes	Floor area (Z3)	Total floor area of the housing units (square meter)	+
	Housing age (Z4)	The age of the housing units counted from the year built	-
	Orientation (Z5)	Most windows facing direction	+
Neighborhood Attributes	Floor (Z6)	The floor level of the housing unit	?
	Structural quality (Z7)	The structural quality is evaluated by the combination of design, materials and the fixtures of the housing units, measured by the satisfaction of the owners according to the 5-points Likert scale	+
	Environment quality around the communities (Z8)	The environmental quality level around the communities are evaluated by the combination of the crime rate, traffic noise and the pollution, measured by the satisfaction of the owners according to the 5-points Likert scale	+
	Inner environment of the communities (Z9)	The inner environmental quality of the communities are evaluated by combination of green area, management, and cleanliness inside, measured by the satisfaction of the owners according to the 5-points Likert scale	+
	Total distance to the nearest life establishments (Z10)	The total distance to the nearest supermarket, restaurant, bank, post office, hospital from the housing unit	-
	Total distance to the nearest educational services (Z11)	The total distance to the nearest kindergarten, elementary school, middle school, college/university from the housing unit	-
	Total distance to the nearest entertainment facility (Z12)	The total distance to the nearest park, cinema, museum, gymnasium from the housing unit	-

Source: create by author

### 3.4 DATA COLLECTION

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The housing market in Kunming is generally fit for the assumptions of the hedonic pricing model. This study focused on the urban area of Kunming and the housing type of condominium to ensure the homogeneity of the housing samples. The housing transactions were relatively active in 2009 and the transacted price relative stable as well. The multiple transaction quantity in real estate market during 2009 in Kunming was 78,201 units (Kunming Statistics Bureau, 2010). According to the calculation by Taro Yamane's formula (Yamane, 1973), this study selects 204 housing units which transacted during 2009 to establish the hedonic price index.

## 4. EMPIRICAL RESULTS

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This study selected the housing units in urban area of Kunming which transacted during 2009 in the housing market with 204 sample units. With the data reorganized and arrangement, the data of 198 samples units were available, the characteristics of sample housing units shows as follows:

### 4.1 THE DESCRIPTIVE OF THE SAMPLE HOUSING UNITS IN KUNMING

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The study defined housing price as the dependent variable and 12 housing characteristics as the independent variables, which are distance to CBD (DCBD), number of the bus routes within 500 meters around the communities (BR), housing floor area (FA), housing age (Age), orientation of the housing units (Orientation), floor level of the housing units (Floor), structural quality (SQ), environmental quality around the communities (ENQ), inner environmental quality of the communities (IENQ), total distance to the nearest life establishments (TDLE), total distance to the nearest educational services (TDES) and total distance to the nearest entertainment facilities (TDEF) to construct hedonic pricing model in Kunming. The descriptive statistics of the variables shows as follows:

Table 2 The characteristics of the sample housing units

Characteristics (unit)	Minimum	Maximum	Mean	Std. Deviation	Variance
Price (Yuan)	178,000	1,200,000	5.04E5	195803.286	3.834E10
DCBD (kilometer)	.50	5.00	2.9672	1.19970	1.439
BR (line)	2.00	21.00	6.3586	2.83876	8.059
FA (square meter)	43.00	177.00	78.6899	19.94636	397.857
Age (year)	1.00	17.00	6.7828	3.20387	10.265
Orientation	.00	1.00	.6717	.47078	.222
Floor (level)	1.00	16.00	4.8788	2.89327	8.371
SQ (point)	1.00	5.00	3.1818	.82921	.688
ENQ (point)	1.00	5.00	3.2677	.77004	.593
IENQ (point)	1.00	5.00	3.3182	.77050	.594
TDLE (kilometer)	2.00	5.50	3.3535	.77477	.600
TDES (kilometer)	2.00	6.00	3.8965	.78736	.620
TDEF (kilometer)	2.00	7.00	4.2222	.91995	.846

Source: Author's Calculation

In table 2, the total price (P) of the sample housing units ranges from 178,000 Yuan to 1,200,000 Yuan with a mean housing price of 504,000 Yuan.

The distance to Center Business District (DCBD) is approximately scaled from 500 meters to 5 kilometers with a mean distance of 2.97 kilometers. There is 2 to 21 bus routes (BR) within 500 meters around the communities with an average number of the bus routes is approximately 6, which indicated that the public transportation condition is relatively convenient for the sample households in Kunming.

The floor area (FA) of the housing units ranges from 43 to 177 square meters, the average floor area is 78.69 square meter. The age (Age) of the housing units differs from 1 year to 17 years, the newest had been built one year while the oldest had been built 17 years. The housing orientation (Orientation) is defined as the dummy variable, the south facing housing set as 1 and other directions set as 0. The floor level of the housing units ranges from the first to the sixteenth floor, the mean of the floor level is the fifth, which indicated that most of sample housing units relatively on a low floor level.

The structural quality, environmental quality around the communities and inner environmental quality are measured by the satisfaction of the sample households according to 5-point Likert scales, the mean of these three variables are at the points of 3.18, 3.27, 3.32, respectively, which indicates that most of housing units at a fair quality of these three characteristics.

The total distance to the nearest life establishments, education services, entertainment facilities are respectively ranges from 2 to 5.5 kilometers, 2 to 6 kilometers, 2 to 7 kilometers. The mean distance of these three characteristics are 3.35 kilometers, 3.89 kilometers and 4.22 kilometers, respectively.

## 4.2 THE REGRESSION OF THE HEDONIC PRICING MODEL

This research applied the multiple regressions with Ordinary Least Square (OLS) to estimate the hedonic pricing model applying the three functional forms.

Model 1: linear functional form

$$P = \beta_0 + \sum_{i=1}^{n=12} \beta_i Z_i + \varepsilon \quad (i = 1, 2, 3 \dots n) \quad (3)$$

Model 2: log-log form/ double log functional form

$$\ln P = \beta_0 + \sum_{i=1}^{n=12} \ln \beta_i Z_i + \varepsilon \quad (i = 1, 2, 3 \dots n) \quad (4)$$

Model 3: Semi-log functional form

$$\ln P = \beta_0 + \sum_{i=1}^{n=12} \beta_i Z_i + \varepsilon \quad (i = 1, 2, 3 \dots n) \quad (5)$$

The regression results of the models by applying the three functional can be summarized in following table:

Table 3 The regression coefficients of thee functional form

	Model 1 Linear functional form	Model 2 Log-Log functional form	Model 3 Semi-Log functional form
(Constant)	123343.114 (1.651)	9.368 (57.179)	12.607 (119.274)
DCBD	-46216.359*** (6.129)	-.167*** (9.578)	-.085*** (8.000)
BR	11104.140*** (5.676)	.095*** (4.736)	.012*** (4.366)
FA	4836.622 (23.806)	.910*** (38.390)	.010*** (33.999)
AGE	-2439.291 (1.087)	-.124*** (7.082)	-.019*** (6.033)
Orientation	-6203.038 (.693)	-.007 (1.573)	.003 (.222)
Floor	571.058 (.431)	.052 (.838)	.000 (.170)
SQ	15578.534* (1.878)	.071** (1.991)	.022* (1.898)
ENQ	26610.537*** (3.278)	.113** (2.622)	.022* (1.954)
IENQ	21156.831** (2.559)	-.016*** (3.764)	.048*** (4.070)
TDLE	-14260.380* (1.967)	-.118 (.472)	-.029** (2.795)
TDED	-5306.145 (.812)	-.101*** (3.866)	-.022** (2.424)
TDEF	-12732.095** (2.141)	.018** (3.138)	-.032*** (3.851)
R square	.939	.973	.969
Adjusted R square	.935	.972	.967

Note: The number in table is coefficients of variables, the number in ( ) is t- statistic

\*\*\* Significance level at 0.01; \*\* significance level at 0.05; \* significance level at 0.1

In table 3, the regression result shows that R square is 0.939 and adjusted R square is 0.935 by the linear functional form, R square is 0.973 and adjusted R square is 0.972 by log-log functional form and R square is 0.985 and adjusted R square is 0.969 by the semi-log functional form. The results of all three functional forms show that housing price can be explained by the model very well. The VIF of variables were all less than 10 by three functional forms at an acceptable level.

The result of applying the linear functional form can be concluded that 8 variables entered into the model, the distance to CBD has a negative relationship with the housing price at 0.01 level of significance. The distance to CBD increases one kilometer, the housing price decreases by 46216.36 Yuan, ceteris paribus. The number of bus routes has a positive relationship with the housing price at a 0.01 level of significance. One more bus route within 500 meter around the communities would raise the housing price by 10752.71 Yuan, ceteris paribus. The floor area has a positive relationship with the housing price at 0.01 level of significance, the floor area increase per square meter, the housing price will increases by 4836.62 Yuan. The housing structural quality, environmental quality around the community and inner environmental quality of the community have a positive relationship with the housing price at the significant level of 0.1, 0.01 and 0.05, respectively, when the quality improved one level, the housing price would increase by 15578.53 Yuan, 26610.54 Yuan, and 21156.83 Yuan, respectively. The total distances to the nearest life establishments (e.g. supermarket, restaurant, bank, post office, hospital) and entertainment facilities (e.g. park, cinema, museum, gymnasium) are proved to have a negative relationship with the housing price with a significant level of 0.1, and 0.05, respectively. The total distance increased one kilometer, the housing price decreases by 14260.38 Yuan and 12732.10 Yuan, respectively.

There were 9 variables entered into the model by using the log-log functional form, of which 4 variables have a negative relationship and 5 variables have a positive relationship with the housing price. The distance to CBD has a negative relationship with the housing price at a significant level of 0.01. If the distance to CBD increases by 1%, the housing price would decrease by 16.7%. On the other hand, the number of bus routes has a positive relationship with the housing price at the significant level of 0.01. When the bus routes within 500 meters around the communities' increases by 1%, the housing price would raises by 9.5%. The floor area has a positive relationship with the housing price at significant level of 0.01. With a 1% increase in floor area, the housing price would increase by 98.8%. The housing age has a negative relationship with the housing price at the significant level of 0.01. When the housing age increases by 1%, this would lead 12.3% decrease on housing price. The structural quality, environmental quality around the communities, and inner environmental quality of the community have a positive relationship with the housing price. When the quality of housing unit improved 1% in level, the housing price would increase by 5.2%, 7.1%, and 11.3%, respectively. The total distances to the nearest educational facilities (kinder garden, primary school, middle school, university) and total distance to the nearest entertainment facilities (park, cinema, museum, gymnasium) from the communities have a negative relationship with the housing price. When the total

distance increases by 1% from the educational services and the entertainment facilities, the housing price would decrease by 11.8% and 10.1%, respectively.

The regression result of using semi-log functional form shows that 10 variables entered into the model, 5 variables have a negative relationship and 5 variables have a positive relationship with the total housing price. Same as the linear functional form, the VIF of distance to CBD is greater than 5 but less than 10, and due to it is an essential characteristic effecting on housing price which cannot be ignored. The distance to CBD has a negative relationship with housing price at a significant level of 0.01. When the distance to CBD increased one kilometer, the housing price would decrease by 8.5%. The number of bus routes has a positive relationship with the housing price at 0.01 level of significance. If there is one more bus route within 500 meters around the communities, the housing price would raise by 1.2%. The floor area has a positive relationship with the housing price at 0.01 level of significance. One square meter increase would cause the housing price to increase by 1.0%. The housing age has a negative relationship with the housing price at 0.01 level of significance. If one year increases of the housing age, the housing price would decrease by 1.9%. The structural quality, environmental quality around and inside the communities has a positive relationship with the housing price. If the quality of which improved by one level, the housing price would increase by 2.2%, 2.2% and 4.8%, respectively. The total distances to the nearest life establishments (supermarket, restaurant, bank, post office, hospital), educational facilities (kinder garden, primary school, middle school, university), and entertainment facilities (park, cinema, museum, gymnasium) from the housing units have a negative relationship with housing price. The total distance increases one kilometer from the life establishments, educational services and entertainment facilities, the housing price would decrease by 2.9%, 2.2%, and 3.2%, respectively.

It can be concluded from the all three models that floor area always the first significant characteristic among three functional forms, followed by the distance to CBD which is predominantly effecting on the housing price. Even though the characteristic of the housing age is rejected by the linear functional form, it is the third important in the log-log and the semi-log functional forms impacting on the housing price. Interest, number of the bus routes is thirdly significant in the liner function form, fourthly significant in log-log functional form, and fifthly significant in semi-log functional form. The ranking of other characteristics are different in three functional forms, but they still implicitly contribute to the housing price of the housing units in Kunming.

## 5. CONCLUSION

The application of hedonic pricing model in real estate market has a long history with the plenty of studies to estimate the relationship between house value and its related characteristics. However, the selection of variables is distinguished in various studies as a result of the preferences on characteristics is not the same, such as the geographical feature and unique culture in various places. A typically example is the climate factor in Kunming, with the mild climate, the cooling system or central air condition is not necessary and not applicable in condominiums, which is hardly effecting both on household preference and housing price in Kunming. On the other hand, it has a great impact on households' preference in other cities, such as Beijing and Shanghai in China.

The results of regression demonstrate that R square and adjust R square of three functional forms were all very high, it indicated that the housing price can be explained by the independent variables in Kunming very well. The coefficients of housing characteristics entered into the model were same sign as the expected of hypotheses by all three functional forms. In general, there are 8 variables entered into the model by linear functional form, 9 variables entered into the model by log-log functional form and 10 variables entered into the model by semi-log functional form. Especially, the R square and adjusted R square by log-log functional form was the highest among all, and the VIF of the characteristics were all lower than 5 at an more acceptable level. The housing characteristics of floor area and distance to CBD are mostly important by all three functional forms. They took the first and second places in significance on affecting housing price in all three functional forms. Although other characteristics are ranked differently in three functional forms, they still partially contribute to housing price of sample housing units in Kunming.

The application of hedonic pricing model based on some assumptions. However, the housing markets in real world are difficult to entirely satisfy all these assumptions due to the situation is more complex in real economic world. Besides, the variable of distance to CBD with a higher VIF both in linear and semi-log functional form, which indicating it exists multicollinearity with other characteristics due to the CBD is highly concentration of many supporting facilities. However, it is an essential characteristic affecting the housing price which cannot be deleted. This study applied the cross-section data that ignored the time factor which would effect on housing price.

## 6. RECOMMENDATIONS

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According to the empirical results, the following recommendations would be useful for the housing producers, consumers, the local governors and city planners in Kunming.

For housing producers, they can improve the new housing constructions to satisfy consumers' preference and maximize their profits. For instance, producers can build the new housing units that close to CBD and construct the housing units with a larger floor area. Besides, improving housing structural quality, inner environment of the community to be more beautiful and clean and adding more convenient facilities to satisfy households' preference and increase the utility of housing units.

For consumers, the results can help consumers understand how the characteristics impact on housing price in Kunming. Due to floor area and distance to CBD are mostly significant impacting on housing price, along with the other characteristics impacting the housing price, it can help consumers to estimate the value of a housing unit when they have a plan to invest or sell a housing unit in Kunming.

The local governors can improve the macro-controlling on housing market in Kunming. For example, the housing price is mostly impacted by the distance to CBD and floor area, accordingly, the local governors can control the land supply inside or around this area and suggest the producers to build the new housing units with a proper floor area to make sure most of households can afford it. In additional, the city planners can improve infrastructures, strengthen the public security administration to reduce the crime rate, better the public environment around the residential areas, and offer more convenient facilities and amenities to the households who live far away from CBD or increasing the number of bus routes around these communities.

Finally, suggestions to the future researchers can be concluded from two aspects. Firstly, researchers can improve their study by selecting more or less variables to construct the hedonic pricing model and estimated how these characteristics significantly impact on housing price, secondly, researchers can measure these housing characteristics in a different way to get the new findings.

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