

Effect of Geographical Location on the Spatial Differences of Housing Price in Xi'an: Based on the Second-hand Housing Data of Family Scale from 2019 to 2021

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ABSTRACT

The price of housing has always been concerned by all people in the society, and it is closely related to the basic life of residents and the stable development of society. In cities, housing prices have many influencing factors, and there are obvious differences among different cities or within the same city. This paper takes Xi'an as the research object, and the specific research areas are six main urban areas of Xi'an. Based on the household-scale second-hand housing data from 2019 to 2021, it discusses the influence of geographical location on the spatial difference of housing prices in Xi'an. In this paper, using Kriging interpolation method and bidding rent theory, firstly, the spatial structure characteristics of housing prices in Xi'an are summarized. Because Kriging interpolation method is selected, the research data should conform to the normal distribution. Therefore, before Kriging interpolation method is used, the data should be analyzed and converted in spss software to make it conform to the conditions. Then, select appropriate influencing factors to construct Hedonic characteristic price model to study the influencing factors of housing prices, and the results are as follows: (1) The housing price in Xi'an is significantly different among different regions, and has formed a unique core area in each region, such as Qujiang New District and Hi-tech Zone, where high housing prices are concentrated. (2) The distance from the center and sub-center of Xi'an has a great influence on the house price, and basically accords with the theory of bidding rent, that is, the house price gradually shows a downward trend with the distance from the center or sub-center. (3) Architectural features, location features and neighborhood features all have an impact on the housing price in Xi'an, among which location features have the greatest impact, architectural features have a greater impact, and neighborhood features have the least impact. Among the factors that affect the housing price due to geographical location, the distance from Xi'an city center and sub-center has the greatest impact on the housing price, and the distance from the nearest park, scenic spot and shopping plaza has a profound impact on the housing price.

KEYWORDS

Housing price; Geographical location; Kriging interpolation; Bidding land rent theory; Hedonic model

1. INTRODUCTION

Housing price has always been a topic of concern and hot spot for many people in society, because it is closely related to everyone, and also has an important connection with the stable social and healthy economic development. Since the reform of China's housing system in 1998, housing prices have risen rapidly, with an average annual growth rate of 7% [1]. Because after the reform of the housing system, the monetization, marketization and commercialization of housing distribution have increased the rigid demand and investment demand for housing, which makes the housing price in the city higher and higher [2]. In 2013, the average house price in Xi'an was 6751 yuan/square meter, while it had reached 19924 yuan/square meter at the beginning of 2021. As house prices continue to

rise, the pressure to buy a house has become huge, and more and more people are lamenting that it is difficult to find a house, especially in more developed cities, the house price will also be higher. In this regard, the state's attitude towards the property market is mainly based on regulation and control, aiming to stabilize house prices and restore the residential function of houses. In addition to the purchase restriction policy and real estate tax policy in the first and second tier cities we are familiar with, the state will unswervingly adhere to the positioning of "houses are for living, not for speculation". The general idea is not to use real estate as a tool and means to stimulate the economy in the short term, strengthen the expected guidance, and implement policies to promote the virtuous cycle and healthy development of the real estate industry. Therefore, it is also very necessary to study the reasons for the rapid growth of housing prices. At the same time, there are often significant spatial differences in housing prices within countries or regions, which has become an important topic in human geography and regional economics [3]. Guanzhong area is a rare plain in Shaanxi Province, sandwiched between the Loess Plateau and the Qinling Mountains. The Weihe River, as the main tributary of the Yellow River, crosses the entire Guanzhong Plain from west to East and joins the Yellow River near Fenglingdu. Above the Guanshan basin in the middle of the Yellow River Basin is Xi'an, which we are familiar with. Xi'an is the only megacity in Northwest China and also an important node city of the "belt and road initiative", so Xi'an has an important position in Northwest China and even the whole country. Taking the six main urban areas of Xi'an as the research area, studying the spatial difference of housing prices in Xi'an and its influencing factors will help the real estate market in Xi'an develop more stably and healthily. To sum up, this paper discusses the current situation and influencing factors of spatial differences in housing prices in Xi'an. The research results can play a positive role in the stable development of the real estate market in Xi'an, and can also provide reference for consumers who need to buy houses, and provide reference and basis for the government to formulate relevant policies in practical application.

2. DATA AND RESEARCH METHODS

2.1. Study Area

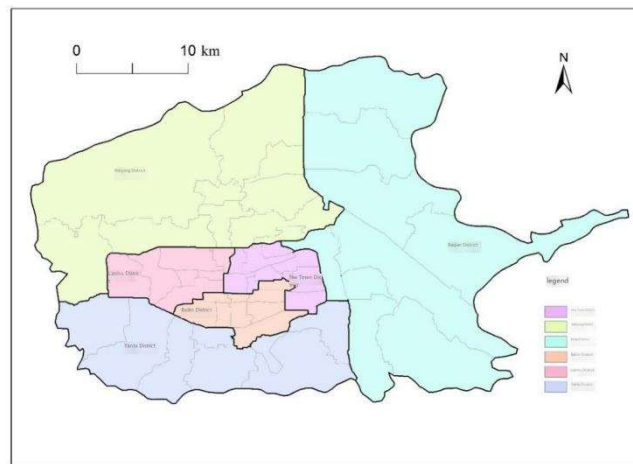


Fig.1 Map of research area

Xi'an is located in the middle of Guanzhong Plain, adjacent to Weihe River in the north and Qinling Mountains in the south. Xi'an is a prefecture level city, provincial capital and sub provincial city under the jurisdiction of Shaanxi Province. The total area of the city is 10108 square kilometers. At the same time, Xi'an is also an important central city in Northwest China. By the end of 2021, the permanent population of Xi'an (including Xi'an Xianyang co administered area) was 13.163 million. In order to ensure the accuracy of the study, the main urban area of Xi'an (Weiyang District, Lianhu

District, Xincheng District, Yanta District, Beilin District and Baqiao District) is selected as the specific research area for analysis.

2.2. Research Data

The initial data of this paper comes from crawling various housing sales and rental websites such as anjuke, 58 Tongcheng, SouFun, etc. using Python to obtain the housing price data of each community in 2019, 2020 and 2021, which is used to study the impact of geographical location on the spatial difference of housing price in Xi'an. Among them, there are 13421 housing price data in 2019, 41112 housing price data in 2020 and 31112 housing price data in 2021. The elements of the data mainly include 16 indicators, such as the name of the residential community, longitude, latitude, area, selling price, orientation, floors, whether there are elevators, property rights characteristics, greening rate, plot ratio, etc., for subsequent research.

2.3. Selection of Hedonic Model Variables

Based on the obtained data, since the Hedonic feature price model will be used in the following text, a total of 12 independent variables including building characteristics, location characteristics, and neighborhood characteristics are selected. The meaning and quantification of the independent variables are shown in the table below:

Tab. 1 Characteristic variable

Feature classification	Variable name	Variable type	Quantification of variables	Expected symbol
Architectural features	Architectural age	continuous variable	Building age=selected year - the year the community was built	-
	Floor location	discrete variable	High rise floor=3, middle floor=2, ground floor=1	unknown
	Orientation state	dummy variable	The orientation is assigned 1 for "south" or "North South", and the rest is 0	+
	Decoration quality	discrete variable	Luxury decoration=5, fine decoration=4, medium decoration=3, simple decoration=2, blank=1	+
area characteristic	Distance from downtown	continuous variable	Distance from the community to the clock towe	-
	Distance from sub center	continuous variable	Distance from the community to SEG Shopping Center	-
	Distance from subway	continuous variable	Distance from the community to the nearest middle school	-
	Distance from shopping center	continuous variable	Distance from the neighborhood to the nearest shopping center	-
	Distance from Park	continuous variable	Distance from the community to the nearest Park	-
	Distance from scenic spots	continuous variable	Distance from the neighborhood to the nearest scenic spot	-
Neighborhood characteristics	greening rate	continuous variable	Greening rate of the community (%)	+
	Plot ratio	continuous variable	Plot ratio (%)	+

2.4. Research Method

(1) Kriging spatial interpolation method

Kriging interpolation, also known as spatial autocovariance optimal interpolation, is an optimal interpolation method named after d.g.krige, a mining engineer in South Africa [4]. The essence of Kriging interpolation is to use the original data of regionalized variables and the structural characteristics of variogram to make a linear unbiased optimal estimation of the value of regionalized variables at the unselected points. When using Kriging difference method, we should first ensure that the data conform to the normal distribution, and then the sample size is enough. The data used in this paper meet these two requirements after conversion.

ArcGIS has two Kriging methods: Ordinary Kriging and Universal Kriging. The ordinary Kriging model has five available semivariograms. The Universal Kriging model has two available semivariograms. Each semivariogram has several optional parameters that can be set. This paper uses the ordinary Kriging method, which assumes that the attribute value is stable in space, that is, it represents the attribute value, represents the spatial position, is a constant, and represents the random disturbance term with constant variance.

(2) Bidding rent curve analysis method

Bidding rent refers to the maximum fee that a person is willing to pay for land in different locations. Johanvonthiinen first proposed the theory of bidding for land rent in a book. Later, it was further improved by scholars represented by Alonso, making the theory more complete and reliable [5]. A bidding rent curve can be drawn according to the bidding rent theory. Alonso believed that the closer to the city center, the higher the land rent needed to be paid. With the increase of the distance from the city center, the rent needed to be paid gradually decreased due to various factors, such as the increase of transportation fees. This is because the subjects' dependence on transportation is mostly different, so their ability to pay is different, so the slope of the corresponding land rent curve is also different in all sectors. This paper mainly makes the bidding rent curve of Xi'an city center and sub center from 2019 to 2021, and analyzes it.

(3) Research on the influencing factors of housing price -- hedonic hedonic hedonic price model

In 1939, count first proposed the hedonic price model (HPM). At that time, count proposed this model to study the influence of the characteristic factors of the car on the price of the car. Later, Lancaster introduced real estate and economics into the hedonic price model [6]. According to the application of hedonic model, the data obtained in this paper are divided into three categories: architectural characteristics, location characteristics and neighborhood characteristics, and then according to hedonic's function expression:

$$P = f(L, S, N) \quad (1)$$

the general expression of residential characteristic price in this paper is obtained. This method is less subjective, and it is a more scientific method to study the influencing factors of housing price introduced from western developed countries. The results are scientific and authentic, and can have a good evaluation effect.

3. RESEARCH RESULTS

3.1. Analysis on Spatial Difference of Housing Price

To analyze the spatial difference of housing prices in Xi'an, the simple Kriging interpolation method is used. The geostatistical analysis tool is called in Arc GIS, and the ordinary Kriging interpolation method is selected to perform spatial interpolation on the price data of ordinary housing in the study area. The spatial interpolation map of housing prices in Xi'an from 2019 to 2021 is obtained:

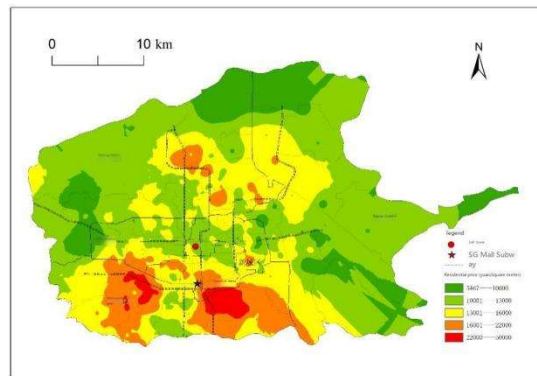


Fig.2 2019 Spatial Interpolation of Study Area

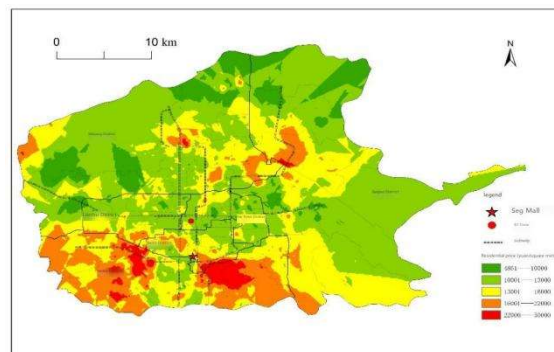


Fig.3 2020 Spatial Interpolation of Study Area

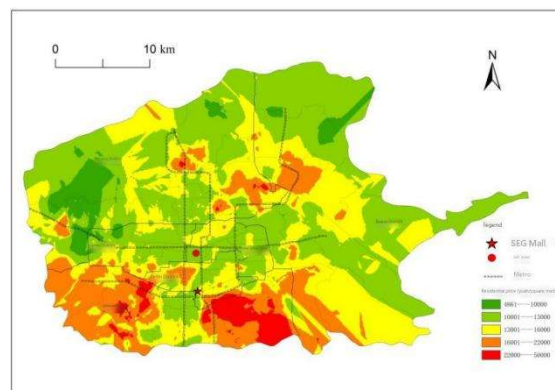


Fig.4 2020 Spatial Interpolation of Study Area

Based on the spatial interpolation map of residential prices in the six districts of Xi'an city from 2019 to 2021, the distribution characteristics of residential prices in Xi'an city are as follows:

(1) From the three-year data, it can be seen that housing prices have shown an overall upward trend year by year. The overall distribution has not changed much, but the spatial distribution of housing prices each year is not stable, with significant price differences, generally manifested as a situation where housing prices are high in the south and low in the north, and high in the east and low in the west. Among them, the overall housing prices in Yanta District are very high, and there is a peak in high housing prices in Qujiang New District, with the second peak located in the High tech Zone. In the 1980s, Qujiang was still a suburban area of Xi'an. In the early 21st century, Qujiang entered the "Qujiang Model" of large-scale transformation and development. Since 2002, it has developed rapidly, forming the core urban area of Xi'an with "one heart, two belts, three axes, and four blocks". The Qujiang residential area is also continuously extending southward, from Dayanta Street to Weiqu; Xi'an High tech Zone has always been a gathering place for high-tech industries in Xi'an, and is also one of the representatives of modern industries in Xi'an. The high-tech core area is located in the electronic west street, high-tech sixth road, high-tech second road, and Tangyan road of the South Third Ring Road. Technology drives economic development, thereby increasing housing prices, which can serve as the secondary peak of housing prices in Xi'an. Outside of this core area, housing prices also decrease with distance.

(2) The number of high housing prices around the secondary center of Xi'an (SEG Shopping Center) is higher than that in the center of Xi'an (Bell Tower). The development speed of Xiaozhai commercial district is rapid, surpassing the original Bell Tower commercial district, which has driven up the prices of surrounding houses.

(3) The distribution of high housing prices in Xi'an is not very concentrated, but presents a scattered distribution, mainly concentrated in the core areas of each district; At the same time, the distribution of low - and medium priced residential buildings is relatively even, all located on the edge of various districts, making Xi'an city present a multi-core clustered location distribution as a whole. A typical example is the high priced gathering place in Qujiang New District in the south of the city. In addition, the Weiyang District in the north of the city is also very typical. The high housing prices in Weiyang District are mainly concentrated in the core area surrounded by Fengcheng 11th Road, Fengcheng 6th Road, Mingguang Road, and Kaiyuan Road in the North Third Ring Road. The municipal government of Xi'an is also located in this core area, which concentrates a large number of office, residential, and commercial centers.

3.2. Analysis of Characteristics of Bidding Land Rent

This article is based on the theory of bidding land rent and uses R language to draw scatter plots of residential prices - distance from the city center and residential prices - distance from the secondary center from 2019 to 2021, representing the bidding land rent curve. Comparing the plots, it can be seen that the spatial distribution of residential prices is more affected by the distance from the secondary center.

From the graph, it can be seen that the bidding rent curve in 2019 does not conform to the bidding rent theory, but the bidding rent curves in 2020 and 2021 do conform to the bidding rent curve.

In 2019, as the distance from the clock tower increased, housing prices first peaked and then slowly declined. According to the bidding rent theory, the closer to the city center, the higher the housing prices, which clearly does not comply with the bidding rent theory. The 2019 bidding land rent curve chart presents three stages: the first stage is from 0m to 5000m away from the clock tower, during which housing prices are mainly concentrated below 20000 yuan/square meter; The second stage is located 5000m to 7000m away from the clock tower. During this stage, housing prices rapidly increase as the distance from the clock tower increases, reaching a peak at 7000m away. According to the analysis above, this area is Qujiang New District; The third stage is further away from the clock

tower, and as transportation costs increase, housing prices begin to slowly decline. These three stages objectively exist, such as the old residential areas near the city center, which are no longer suitable for living due to their long renovation and construction time, and the beautiful environment and many scenic spots in Qujiang New District, which have led to an increase in housing prices due to various factors. In 2020 and 2021, housing prices showed a wave like pattern as the distance from the clock tower increased, with multiple rises and falls. Both years saw changes compared to 2019, with an increase in the number of high housing prices as the distance from the clock tower increased. The highest value was reached earlier at a distance of 4000 meters from the clock tower, indicating rapid growth in housing prices around the clock tower. The bidding rent curve in these two years basically conforms to the bidding rent theory.

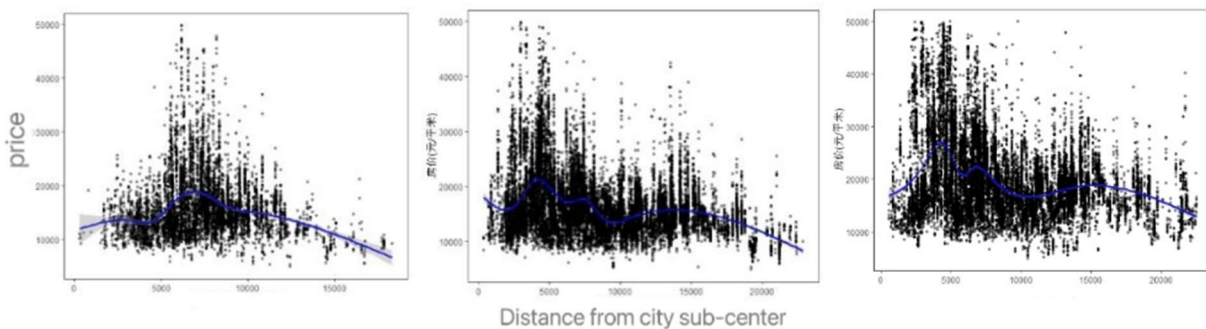


Fig.5 (center) Bidding rent curve of 2019—2021

The following graph shows the curve presented as the distance from the sub center of Xi'an increases, and the results are basically consistent with the bidding location

The rental theory states that the further away from the secondary center (SEG Shopping Center), the more obvious the downward trend in housing prices, and there is no significant change in the three-year trend. Taking 2019 as an example, analyzing the stages of change, the first stage is from 0m to 4000m away from the secondary center. During this stage, as the distance from the secondary center increases, housing prices gradually rise, reaching their peak at 4000m and then beginning to decline significantly; The second stage is from 4000m to 10000m away from the secondary center, during which the price of houses rapidly decreases as the distance increases; The third stage is from 10000m to 14000m away from the secondary center, during which housing prices show a slight upward trend; The final stage is when the distance from the center to the west exceeds 14000m, resulting in a continuous decrease in housing prices as the distance increases. The overall trend from 2019 to 2021 has not changed, only the distance to reach the peak point is different. The reason for its formation is Xi'an SEG International Shopping Center, located at the intersection of Chang'an Road and Xiaozhai Road, occupying a golden position in the northeast corner of Xiaozhai Cross, with a total construction area of 230000 square meters and a commercial area of 200000 square meters. It is currently the largest commercial single project in Xi'an. SEG International Shopping Center gathers more than 600 well-known brands from home and abroad, creating a modern interactive experiential urban shopping center with international comprehensive service level that integrates life, leisure, and entertainment. The proximity to the internationally renowned attraction of the Big Wild Goose Pagoda has led to an increase in residential prices in the surrounding area.

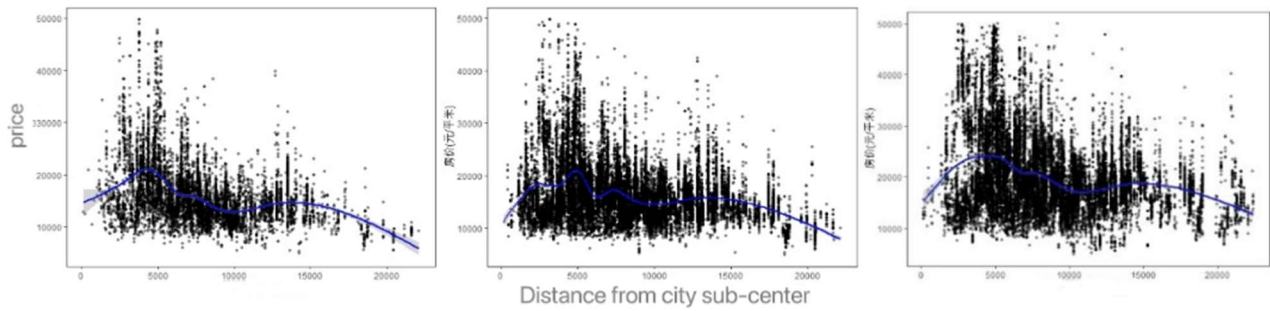


Fig.6 (subcenter) Bidding rent curve of 2019--2021

3.3. Analysis on Spatial Difference of Housing Price

According to the Hedonic model, the above variables for 3 years of regression analysis, each year's dependent variables are housing prices, the independent variables are selected from the distance from the center of Xi'an and from the sub-center of Xi'an, the rest of the independent variables remain unchanged. The results of regression analysis show that the architectural characteristics, location characteristics and neighborhood characteristics will have an impact on the housing price in Xi'an, of which the location characteristics have the greatest impact, the architectural characteristics have a greater impact, and the neighborhood characteristics have the least impact. Specific results are as follows:

Tab.2 Regression coefficient in 2019

feature classification	Variable name	coefficient value	t	coefficient value	t
Architectural features	Architectural age	0.020***	4.238	0.032***	7.264
	Floor location	-0.106***	-21.210	-0.058***	-12.097
	Orientation state	-0.038***	-7.907	-0.029***	-6.483
	Decoration quality	-0.139***	-36.655	-0.090***	-24.268
area characteristic	Distance from downtown	0.001	0.167	0.027***	6.017
	Distance from sub center	0.050***	5.265		
	Distance from subway			-0.230***	-36.858
	Distance from shopping center	0.102***	14.407	0.108***	16.391
	Distance from Park	-0.018***	-48.327	-0.020***	-26.715
	Distance from scenic spots	-0.003	-0.736	-0.004	-1.205
Neighborhood characteristics	greening rate	0.107***	11.663	0.022***	10.102
	Plot ratio	0.008***	18.483	0.007***	22.646
Architectural features	Architectural age	-0.006***	-7.480	-0.007***	-9.704
constant		10.697	124.056	12.232	177.991
Sample size: 8867					
AdjustedR ²		0.284		0.377	
Comments: * p<0.1, **p<0.05, ***p<0.01					

Tab.3 Regression coefficient in 2020

feature classification	Variable name	coefficient value	t	coefficient value	t
Architectural features	Architectural age	0.033***	15.933	0.033***	15.847
	Floor location	-0.072***	31.392	-0.070***	-30.246
	Orientation state	-0.053***	-21.210	-0.055***	-21.709
	Decoration quality	-0.074***	-40.665	-0.075***	-41.009
area characteristic	Distance from downtown	0.035***	21.515	0.039***	24.288
	Distance from sub center	-0.136***	-50.415		
	Distance from subway			-0.145***	-48.821
	Distance from shopping center	0.095***	27.344	0.096***	27.465
	Distance from Park	-0.019***	-62.640	-0.019***	-62.925
	Distance from scenic spots	-0.020	-11.735	-0.020	-11.692
Neighborhood characteristics	greening rate	0.026***	21.783	0.026***	21.618
	Plot ratio	0.007***	36.099	0.007***	37.098
Architectural features	Architectural age	-0.017***	-23.270	-0.018***	-24.848
constant		11.633	389.806	11.682	380.684
Sample size: 30339					
AdjustedR ²		0.351		0.348	
Comments: * p<0.1, **p<0.05, ***p<0.01					

In the regression analysis in 2019, the greatest impact on the price of housing in Xi'an is the distance of the housing from the sub-center (SEG) of Xi'an, with a coefficient value of -0.230. This shows that the closer to the sub-center, the higher the residential price, which is consistent with the bidding ground rent curve above, because the closer to the sub-center, the more prosperous the neighborhood, the better the transportation conditions, the better the services and facilities, and the richer and high-quality employment, so the higher the residential price. Secondly, the distance from the nearest scenic spot, the distance from the nearest shopping center, the degree of decoration and the orientation have a greater impact on the housing prices in Xi'an. The coefficient values are -0.106, -0.139, 0.107 and 0.102 respectively, which are consistent with the expected results. With the development of society, residents are now pursuing a higher quality of life. The closer to the scenic spot and shopping plaza, the better the room decoration, the better the living conditions and quality can be guaranteed, which will lead to the increase of house price. If the orientation of the house is south or north-south, it means that the house has better lighting, which is also in line with the traditional idea of "sitting north facing south" and makes the house price higher. In addition, the distance coefficient value from the city center of Xi'an is 0.050, which is not in line with the regular bidding rent theory, but it is also consistent with the bidding rent curve above, because the clock tower, once the largest business district in the northwest region, has no past glory. Traffic congestion and poor service in Hui street

often occur, resulting in the house price in the city center not as high as that in Qujiang New District. The distance coefficient value from the nearest subway is 0.001, indicating that the house price will not become higher as the distance from the subway is closer, because the traffic is very developed now, private cars and buses are also very convenient, and the role of the subway is not very significant. The coefficient value from the nearest middle school is 0.020, however, there is no analysis of the distance from the nearest primary school or university, and it is impossible to judge the impact of this education area on the housing price in Xi'an, which needs further research and investigation. The coefficient value of the building age is -0.018, which indicates that the farther the house is built, the lower the price, because the building materials of the house have a life span, and the quality of the old house has problems and contains certain risks, problems such as poor residential environment, poor sound insulation effect and no security also make the house price not as high as that of newly built residential buildings. Finally, the coefficient of greening rate is 0.008 and the coefficient of plot ratio is -0.006. The greening rate determines the living environment of the residential area. The higher the greening rate, the better the living environment of the residential area and the higher the attraction to consumers. At the same time, the higher the greening rate also means the lower the plot ratio, that is, the land used to build houses decreases, and the price of housing increases accordingly.

Tab.4 Regression coefficient in 2021

feature classification	Variable name	coefficient value	t	coefficient value	t
Architectural features	Architectural age	0.038***	14.550	0.038***	14.631
	Floor location	-0.082***	-26.763	-0.071***	-24.017
	Orientation state	-0.052***	-17.281	-0.054***	-17.937
	Decoration quality	-0.024***	-9.913	--0.021***	-7.990
area characteristic	Distance from downtown	0.020***	10.286	0.023***	12.219
	Distance from sub center	-0.145***	-41.242		
	Distance from subway			-0.139***	-36.858
	Distance from shopping center	0.152***	36.291	0.153***	36.478
	Distance from Park	-0.003***	-27.281	-0.003***	-27.354
	Distance from scenic spots	0.152	26.219	-0.001	-5.128
Neighborhood characteristics	greening rate	0.025***	16.817	0.025***	16.783
	Plot ratio	0.010***	39.992	0.010***	40.663
Architectural features	Architectural age	-0.017***	-20.241	-0.018***	-20.228
Architectural features	Architectural age	11.383	391.960	11.546	377.130
Sample size: 28999					
AdjustedR ²		0.284		0.336	
Comments: * p<0.1, **p<0.05, ***p<0.01					

The results of the regression analysis for 2020 and 2021 have not changed much from 2019. The difference is the distance from the center of Xi'an (bell tower). The coefficient value in 2019 is positive, while the coefficient value in 2020 and 2021 is negative, that is, the residential price decreases with the increase of distance from the city center. The result is consistent with the bidding ground rent curve above. With the renovation and "upgrading" of the old residential area near the bell tower business district, and the renovation of the famous scenic spot Bell and Drum Tower, the residential price also increases.

4. SUMMARY

Based on the three-year housing price data of Xi'an from 2019 to 2021, taking the six districts of Xi'an as the research scope, this paper analyzes the spatial differences of housing prices in various districts of Xi'an by using spatial interpolation method and bidding rent curve, and then selects appropriate indicators for regression analysis to explore the influencing factors of housing prices and the impact of geographical location on housing prices. The specific conclusions are as follows:

- (1) There are significant differences in housing prices between different regions in Xi'an, and unique core areas have been formed in each district, such as Qujiang New Area and high tech Zone with high housing prices.
- (2) The distance from Xi'an city center and sub center has a great impact on the housing price, and basically conforms to the bidding rent theory, that is, with the distance from the city center or sub center, the housing price gradually shows a downward trend.
- (3) Architectural characteristics, location characteristics and neighborhood characteristics will all have an impact on housing prices in Xi'an. Among them, location characteristics have the greatest impact, architectural characteristics have a greater impact, and neighborhood characteristics have the least impact. Among the influencing factors of geographical location on housing prices, the distance from Xi'an city center and sub center has the greatest impact on housing prices, and the distance from the nearest Park, scenic spot and shopping mall has a profound impact on housing prices.

REFERENCES

- [1] KYu-Nien Shih and Hao-Chuan Li and Bo Qin.. "Housing price bubbles and inter-provincial spillover: Evidence from China", *Habitat International*, Vol. 43, pp. 142-151, 2014.
- [2] Liu Xilu. "Research on the Regional Differences of Urban Residential Prices in Shaanxi Province", Xi'an University of Architecture and Technology, 2015
- [3] Wang Shaojian, Wang Yang, Lin Xueqin, Wang Ou. "Spatial Differentiation Characteristics and Influencing Mechanism of Housing Prices in County-level Regions of China", *the geographical journal*, Vol. 71(08), pp. 1329-1342, 2016.
- [4] Guo Bingqi. "Research on GPS elevation fitting model based on Kriging method and its application", Xi'an University of Science and Technology, 2008
- [5] Alonso W. "Location and Land Use", Harvard Univ. Press, Cambridge, MA, 1964.
- [6] Kelvin J. Lancaster. "A New Approach to Consumer Theory", *Journal of Political Economy*, Vol. 74(2), pp. 132-157, 1966.