A Study on Spatial Distribution of Commercial Housing Prices in Xiangtan City

Jinning XIE * , **Qinxiang SONG**

School of Architecture and Art Design，Hunan University of Science and Technology，Xiangtan 411201，China

Abstract   ArcGIS technology is used to study the spatial pattern of housing prices in Xiangtan City，and it is found that the spatial pattern of housing prices shows primary and secondary two-center rings. In Hedong Jianshe Road and near Hexi Jijianying，there are primary and secondary polar nuclei，respectively；the secondary housing price area is located near the east-west and south-north trunk road in the urban area；there are significant regional differences in housing price changes（fastest reduction of prices in the Hedong main center-southwest direction；slow reduction of prices in the main center-northwest，southeast direction；slowest reduction of prices in the main center-northeast direction）. In Hexi sub-center，except slow reduction of prices in the Xiangjiang River direction，the prices decline rapidly in other directions. The housing prices exhibit an obvious overall decreasing trend from primary and secondary centers to the suburbs，but there are also exceptions. On this basis，this paper analyzes the driving factors for spatial pattern of housing prices in Xiangtan City，and finds that the spatial pattern of housing prices is mainly influenced by commercial centers，residential environmental conditions，traffic conditions，and urban land layout differences.

Key words   Housing prices，Urban spatial pattern，ArcGIS，Xiangtan City

1   Introduction

Commercial housing is an important part of the real estate market，and since China began its reform of housing system，housing prices have become the focus of attention for the government，residents，developers，and academics. There are significant differences in housing prices between cities，and even in different areas of the same city，the housing prices show significant differences[1]. It is an urgent problem to study the spatial differentiation of housing prices within city and its mechanism. The domestic empirical analysis on spatial distribution pattern of housing prices within city is mainly concentrated in first-tier and second-tier cities such as Beijing，Shanghai，Guangzhou and Nanjing[2-7]. In this paper，with Xiangtan City as the research object，we use ArcGIS spatial analysis method to analyze the spatial pattern of housing prices and its driving mechanism，in order to explore the spatial variation characteristics of urban housing in China's four-tier cities，and provide a reference for the development of housing industry in Xiangtan City.

2   Study area，data sources and correction

2. 1   Overview of the study area   Xiangtan（111°58′ – 113° 05′ E，27°21′ – 28°05′ N）is a prefecture-level city in Hunan Province，China，located on the lower reaches of Xiangjiang River，with a total area of 5015 km². At the end of 2015，the city's permanent population was 2. 813 million，and GDP was 170. 31 billion yuan. Xiangtan's city center is the most active region in terms of economic development and urban construction，including Yuetang District，Yuhu District，High-tech Industrial Development Zone，and Economic and Technological Development Zone. In this paper，the study area only includes the two districts and two development zones in Xiangtan's city center. Since 2006，in the context of new round of rapidly rising national housing prices，Xiangtan's housing prices have also begun to rise. After a brief standstill in 2008，Xiangtan's housing prices rose rapidly during 2009 – 2010. In 2010，the state adopted a series of regulatory policies，and Xiangtan's housing prices still maintained a steady rising trend. The housing price changes in Xiangtan are not only due to real estate industrial development，but also related to the Chang-Zhu-Tan urban agglomeration construction，economic restructuring，regional economic policies，urban planning and construction and other factors.

2. 2   Data sources and correction   We obtain the price data of 116 new buildings opened in Xiangtan City during 2006 – 2015 from House 365，Anjuke and Fang. We use GoogleEarth to get the latitude and longitude of each sample point，and use ArcGIS software to establish the spatial property database of Xiangtan City. To enable the average housing price in different years to be comparable，we use the housing sales price index in Xiangtan City during 2006 – 2015 to correct the commercial housing prices during 2006 – 2015 to the comparable prices in 2015. The final results are denoted by the comparable prices in 2015. We use the mode of building coordinates as a batch in ArcGIS to mark the above information on the vector land use map in Xiangtan City，and establish spatial data map of housing project in Xiangtan City during 2006 – 2015（see Fig. 1）. The spatial data map can accurately reflect the spatial distribution of commodity housing projects in Xiangtan's city center during 2006 – 2015.
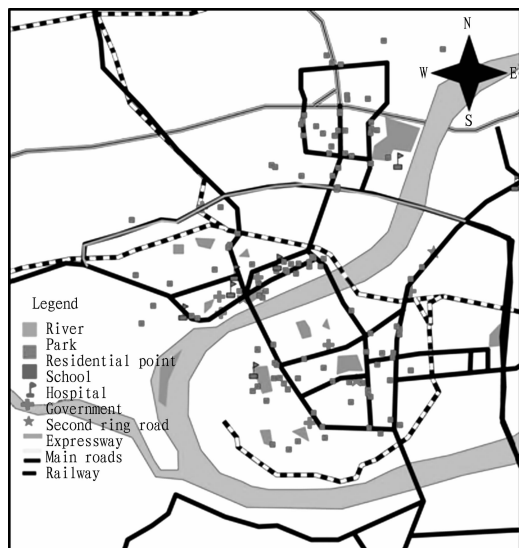
Fig. 1　Residential sample distribution

3　The spatial interpolation analysis of housing prices in Xiangtan City

3.1　Analysis of the spatial characteristics of residential points

3.1.1　Average nearest neighbor analysis. Average nearest neighbor analysis is a method used to judge the point space state. The judgment is based on the nearest neighbor index. If the index is smaller than 1, it is the spatial concentration mode; if the index is greater than 1, it is the spatial discretization mode[1]. We select the location information of residential points, and use ArcToolbox tool of ArcGIS to analyze the location information of residential points. The results are shown in Table 1, and the nearest neighbor index is 0.659787, less than 1, so it is the spatial concentration mode. And Z value is -7.00987, significantly less than the significance test value of -2.58 at 1%. Based on the above comprehensive analysis, it can be found that the residential agglomeration is very obvious in Xiangtan City.

3.1.2　Spatial autocorrelation analysis. Global spatial autocorrelation is the spatial characteristics description of samples in the study area, and tests whether there is agglomeration effect in variables[8]. There are many indicators and methods to describe the global spatial autocorrelation, and here we use Moran's I. It is calculated as follows:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} a_{ij}(y_i - y_m)(y_i - y_m) / \sum_{i=1}^{n}\sum_{j=1}^{m} a_{ij}}{\sum_{i=1}^{n}(y_i - y_m) \times (y_i - x_m)/n} \tag{1}$$

where y_i is the value of pixel i; y_j is the adjacent pixel value of pixel j; y_m is the mean of raster pixel; a_{ij} is the coefficient, and when j is closest to i, the value is 1, otherwise 0; n is the number of all pixels in a raster.

The results calculated according to Equation (1) are shown in Table 2. From Table 2, it is found that $I = 0.082159 > 0$, indicating that housing prices show the spatial aggregation of similar values on the whole, that is, the closer the values, the more similar the prices. Z value is 7.702127, greater than the bilateral test value of 2.58 at 99% confidence interval, so there is spatial autocorrelation, and the agglomeration is significant.

Table 1　The nearest neighbor analysis of Xiangtan's housing

Number of samples	Average observation distance//m	Average desired distance//m	Nearest neighbor index	Z score	P value
116	0.003475	0.005267	0.659787	-7.009879	0.000000

Table 2　Global autocorrelation analysis of houses in Xiangtan City

Number of samples	Moran I index	Expected index	Variance	Z-score	P value
116	0.082159	-0.008696	0.000139	7.702127	0.000000

3.2　Geostatistical analysis

3.2.1　Normal distribution analysis. Using the histogram and normal QQ plot tool in geostatistical module, the position information of 116 residential points is loaded for data analysis. The results are shown in Fig. 2. From the distribution results, it is found that some points deviate far from straight line, not following normal distribution. By changing the data, it is found that the data log transformation results approximate to normal distribution (see Fig. 3). This provides a theoretical basis for the later use of Kriging interpolation method.

3.2.2　Trend analysis. Global trend analysis can reflect the spatial changes in data, and it ignores individual outliers, looks for trends in overall data distribution in the space, and finally draw the fitting curve. If the fitting curve is not a horizontal line, it indicates a trend. The trend analysis in geostatistical module is used, and the results are shown in Fig. 4.

3.2.3　Kriging interpolation. In this paper, the Kriging interpolation method is based on the trends in regionalized variable data, and spatial autocorrelation. Using Kriging interpolation, we get the interpolation map (see Fig. 5).

4　The spatial distribution characteristics and driving mechanism of housing prices in Xiangtan City

4.1　The two-center ring distribution pattern of housing prices and the driving factors

As shown in Fig. 5, it can be found that Xiangtan's spatial pattern of housing prices shows two-center ring distribution, but not regular concentric distribution. The main center ring (5200 yuan/m² or more) is located near Hedong Jianshe Road. The sub-center ring (4300 yuan/m² or more)
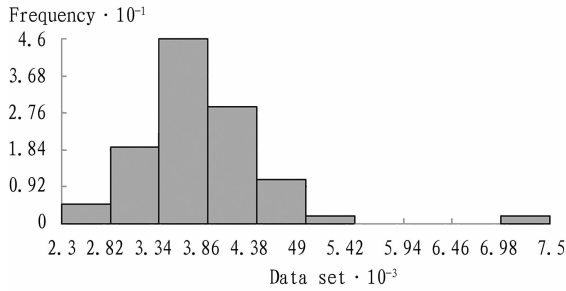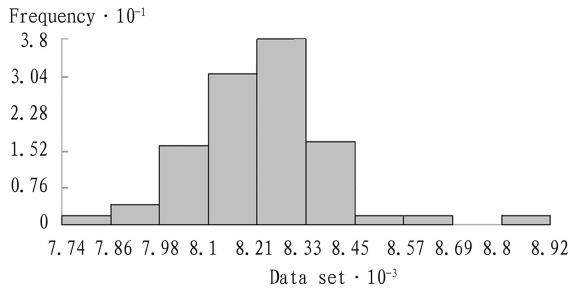
Fig. 2   Normal distribution of raw data
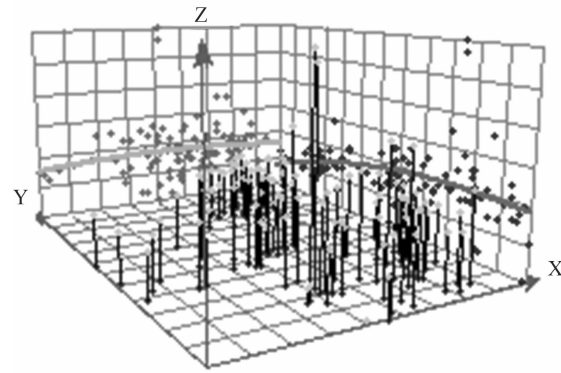

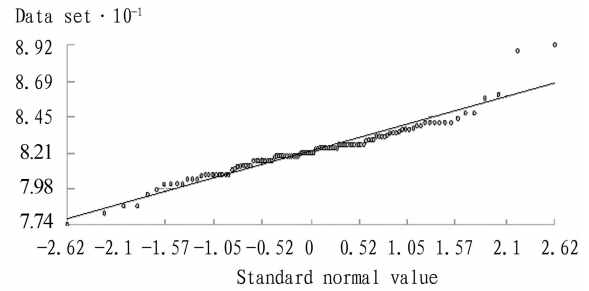Fig. 3   Normal distribution after log processing
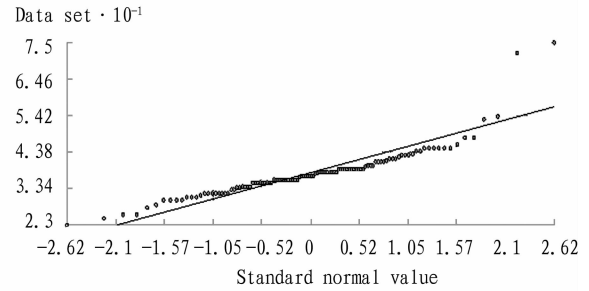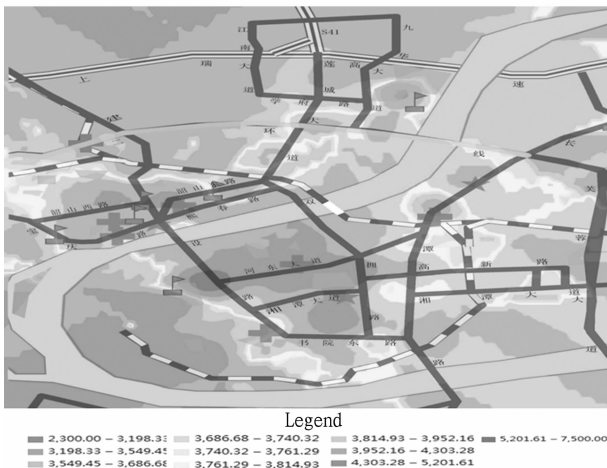

Fig. 4   Trend of commercial housing prices

Legend

2,300.00 – 3,198.3	3,686.68 – 3,740.32	3,814.93 – 3,952.16	5,201.61 – 7,500.00
3,198.33 – 3,549.4	3,740.32 – 3,761.29	3,952.16 – 4,303.28	
3,549.45 – 3,686.6	3,761.29 – 3,814.93	4,303.28 – 5,201.61	

Fig. 5   Spatial interpolation results commercial housing prices in
Xiangtan City

is located near Hexi Jijianying. The two-center ring distribution pattern is mainly driven by the following two factors. (ⅰ) Urban commercial center. Urban commercial center is the place where high-end commercial buildings and department stores are concentrated, and buyers have distinct willingness to pay for living in the vicinity of urban commercial center. The urban commercial center can significantly improve the housing prices in the surrounding regions. Xiangtan City is a fourth-tier city in Central China, and commercial centers play a more prominent role in raising housing prices of the surrounding regions. (ⅱ) Residential environment advantages. The residential environment includes natural environment, and education, culture, business and medical public facility environment. The Hedong area covered by the secondary ring of housing prices (4300 – 5200 yuan/m^2) is located on the both sides of Hedong Avenue from Jianshe Road to Shuangyong Road. In this area, there are central park, university, large themed plaza, leisure and entertainment shopping center, municipal government, radio and television center, and other administrative departments. The Hexi area covered by the secondary ring of housing prices is located in the place where Shaoshan Road, Jianshe Road and Chezhan Road intersect and the surrounding regions. In this area and the surrounding regions, there are Yuhu Park, Heping Park, many schools such as Xiangtan Education College, many shopping centers, as well as the most famous hospital in Xiangtan City—Central Hospital. High housing prices (4300 – 5200 yuan/m^2) appear on both sides of North Second Ring Road, in the east of Liancheng Avenue, and near Jiuhuahu De Cultural Park. In this area, there are Jiuhuahu De Cultural Park, Jiuhua Heping Elementary School, and BBK Commercial Complex. It is adjacent to the scenic belt along Xiangjiang River. Low housing price (3100 – 3800 yuan/m^2) appears in the area from Jianshe Road to Shuangyong Road along the railway, because the trains on the railway bring much noise and do a great damage to human health.

4. 2   Regional differences in housing price changes and the driving factors   Xiangtan's housing prices decreases from urban primary and secondary centers to the suburbs, but the housing

price changes are not consistent in various directions. It decreases most rapidly in the Hedong main center-southwest direction; it decreases slowly in the main center-northwest, southeast direction; it decreases most slowly in the main center-northeast direction. The regional differences in Xiangtan's housing price changes are mainly driven by the following two factors. (ⅰ) Traffic condition differences. From the road network structure of Xiangtan City, it is found that the east-west trunk roads are Hedong Avenue, Xiangtan Avenue and Shaoshan Road, and the south-north trunk roads are Jianshe Road and Shuangyong Road. Xiangtan's high housing price areas are mainly concentrated on both sides of these trunk roads. For the regions in the west of Jianshe Road, there is no trunk road, and west, north and south are surrounded by Xiangjiang River, leading to poor transportation. The traffic condition differences in this region are an important cause of low housing prices in the region. (ⅱ) Urban land layout differences. There are both positive and negative effects for different types of land in the city. Xiangtan Xiangjiang River Scenic Belt Construction Plan covers both sides of Xiangjiang River in Xiangtan City, from $50-100$ m inner side of Riverside Avenue to the surface of the river, with the planning area of about 15 km^2, and it aims to create ecological civilization corridor and cultural inheritance link reflecting Huxiang cultural characteristics. This is the main reason for slow reduction of housing prices from urban centers along Xiangjiang River. Xiangtan is an old industrial city, and affected by air pollution, noise and other factors, the industrial land is dense, and the housing prices are generally low.

5　Conclusions

This paper uses ArcGIS technology to study the spatial pattern of housing prices in Xiangtan City, and finds that the spatial pattern of housing prices shows primary and secondary two-center rings. In Hedong Jianshe Road and near Hexi Jijianying, there are primary and secondary polar nuclei, respectively; the secondary housing price area is located near the east-west and south-north trunk road in the urban area; there are significant regional differ-

ences in housing price changes (fastest reduction of prices in the Hedong main center-southwest direction; slow reduction of prices in the main center-northwest, southeast direction; slowest reduction of prices in the main center-northeast direction). In Hexi sub-center, except slow reduction of prices in the Xiangjiang River direction, the prices decline rapidly in other directions. The housing prices exhibit an obvious overall decreasing trend from primary and secondary centers to the suburbs, but there are also exceptions. On this basis, this paper analyzes the driving factors for spatial pattern of housing prices in Xiangtan City, and finds that the spatial pattern of housing prices is mainly influenced by commercial centers, residential environmental conditions, traffic conditions, and urban land layout differences.

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