Analysis of Residential Space Structure Based on Housing Price in Lanzhou City

Mingtao Li 1* and Qianqian Guo 2
1 College of Geography and Environmental Engineering, Lanzhou City University, Lanzhou 730000, PR China.
2 College of Geography and Environmental Science, Northwest Normal University, Lanzhou 730000, PR China.
*Corresponding author’s e-mail: lzculimt@163.com

Abstract. Based on the residential POI (Point of Interest) data in the central district of Lanzhou, the spatial pattern of housing price were discussed using spatial auto correlation analysis. The results show that: the spatial variation of residence price in Lanzhou presented a point axle type pattern with the east-high and west-low feature. The spatial dependence and anisotropy were apparent in spatial variability of housing price, housing price in different directions have different degrees of spatial autocorrelation. Furthermore, with the increase of variation, the influence of structural components, such as traffic, environment and public service, were becoming more and more significant.

1. Introduction
The spatial-temporal variation of urban housing price have drawn plenty of scholarly attention [1], which is widely used as an indicator in understanding the residential space structure and urban growth [2]. Currently, the higher housing price in China has become the focus among the people. Many scholars have empirically analyzed the spatial and temporal evolution of housing prices [3,4,5], driving mechanism [6,7,8] and influencing factors [9,10] from different perspectives.

Lanzhou, a typical Valley City in arid area of Northwest China, suffers greatly from the problem of high housing price. There have been many studies on the housing prices in Lanzhou [11,12,13], which had enriched the research of residential space in the market. However, while many studies have analyzed the real estate market on the macro level, studies of housing prices on the micro level in Lanzhou are still limited. With the rising of the big data techniques, date of Point of Interest (POI) has become an important data source for urban spatial research[14,15,16]. Under such circumstances, it is meaningful for us to further explore the spatial pattern of housing prices and its determining factors in Lanzhou. Therefore, the main purpose of this article is to examine the spatial distribution of housing prices in Lanzhou, with the big data techniques.

2. Data and method
2.1. Data
This article used the web crawler to acquire exactly 2090 residential POI data from the real estate trading website (http://lz.fang.com/) to analyze the spatial distribution of housing prices in Lanzhou in
December 2018. The distribution of the residential POI is shown in figure 1. Data collected by the web crawler include the price, the age of houses, the volume rate, the greening rate, and the property fee.

Figure 1. The distribution of residential POI in Lanzhou

2.2. Method

2.2.1. Spatial auto-correlation analysis. Spatial autocorrelation analysis mainly examines the spatial distribution of things and their dependence on neighborhood space [17]. It is often measured by Moran’s I method which is defined as:

\[
I = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} (X_i - \bar{X})(X_j - \bar{X})}{S^2 \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}}
\]

\(n\) is the number of samples, \(X_i\) and \(X_j\) are the attribute values of sample \(i\) and \(j\), \(W_{ij}\) is the spatial weight matrix, \(S^2\) is the variance of attribute values, and \(\bar{X}\) is the average attribute value. Values of Moran’s I are in the range of \(-1\) to \(1\). If \(I\) is significantly positive at a given significance level, it means that the sample tends to be positively correlated. If it is negative, it tends to be negatively correlated. When \(I=0\), it means that the samples are randomly distributed in space.

2.2.2. Semivariogram analysis. Semivariogram is a function to study the randomness and structure of regionalized variables. It can well express the spatial variability of geographical variables. By constructing the function of semivariogram and distance, it can be analyzed whether spatial variability belongs to isotropy or anisotropy.

\[
r(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} [Z(x_i) - Z(x_i + h)]^2
\]

\(r(h)\) is a semivariogram, \(h\) and \(N(h)\) represent the sample distance and sample size respectively; \(Z(x_i)\) and \(Z(x_i + h)\) are the attribute values of variable \(Z\) at \(x_i\) and \(x_i + h\) respectively. The main parameters of semivariogram, namely nugget value \((C_0)\) and structural variance \((C)\), reflect the extent to which variables are affected by random factors and structural factors respectively. The nugget coefficient
$C_0/(C_0+C)$ reflects the size of spatial heterogeneity caused by random factors, and the range of variation $(A)$ indicates the size of the range of action of variables.

3. Spatial differentiation characteristics of housing prices in Lanzhou

3.1. Analysis of spatial pattern of housing price

Based on 2090 residential POI data in 2018, the inverse distance weight interpolation method is used to draw the isolines map of housing price with 500 yuan/m$^2$ equivalence distance (see in figure 2).

![Isolines map of housing price in Lanzhou](image)

Figure 2. The isolines of residence price distribution in Lanzhou

Figure 2 shows that the spatial distribution of housing price in Lanzhou formed a clear "point - axis" pattern. For the "point" mode, some significant peaks of housing price are formed in Xiguanshizi, Yantan, and Xizhan. The average of housing prices in these area is above 15000 Yuan /m$^2$. For the "axis" model, the distribution of housing price is consistent with the direction of the river. Housing prices along the river are significantly higher than other areas. Riverview advantage along the Huang River expand the distribution of housing price peaks.

The positive spatial autocorrelation was detected in the housing price with Moran's I is 0.5729. It means that houses which have high prices are likely to cluster together, so do the cheap ones. LISA (Local Indicators of Spatial Association) maps was used to show the significant spatial autocorrelation locations by type of association (see in figure 3). The high-high clusters of housing price are near the Xiguanshizi, Dongfanghong Square, Yantan, Eastern Market, and the low-low clusters are near the Jiuzhou, Gong Jia Wan, Xiu Chuan, Liu Jiabao, Xigu, etc.
3.2. Analysis of spatial direction variation of housing price

The Semi-Variogram shows that, the range (A) is 2.71km, meaning that the spatial correlation between housing price exists significantly within a range of 2.71km. In the range of 0 to 2.71km, the spatial autocorrelation decreases with the increase of distance, and then vanishes at 2.71km. The attenuation radius of the influence of neighbourhood is 2.71 km. The nugget coefficient C0/(C0+C) is 0.397, meaning that the proportion of structural variation is 60.3%, and the random variation is 39.7%. The structural variation is much larger than that of random variation. It reflects that the difference of housing price affected by the determinant factors (such as traffic condition, environmental condition, infrastructure, etc.) is greater than that of random factors (such as policy factors, human factors, etc.). Housing price correlations may be a function of both distance and direction [18]. In this paper, we examine directional autocorrelations along four directions: 0 degree (north-south direction), 45 degree (northeast-southwest direction), 90 degree (east-west direction), 135 degree (southeast-northwest direction).
As can be seen from figure 4, housing price shows anisotropic spatial autocorrelation. The spatial correlation of housing price in the directions of 0 degree (north-south) and 45 degree (northeast-southwest) are relatively close, while those in the directions of 90 degree (east-west) and 135 degree (southeast-northwest) are more distant. In addition, it can be found that all the semi variogram cloud patterns appear undulating, especially in the 90 degree direction, indicating that the distribution of housing price in Lanzhou has certain periodicity in this spatial direction.

4. Conclusion
This article examines the spatial distribution of housing prices in Lanzhou based on the 2090 pieces of housing data with the methods of spatial auto-correlation and semivariogram analysis. The results show that the spatial patterns of housing price in Lanzhou formed a clear “point - axis” pattern. Housing price in Lanzhou shows a polycentric development and reveals an east-west direction expansion. Housing price structure in Lanzhou has a high spatial autocorrelation, and the housing price is still relatively heterogeneous. Furthermore, housing price in different directions have different degrees of spatial autocorrelation. Spatial autocorrelation in east-west direction is more intense than others. Analysis of Semi-variogram also shows that the structural determinants such as transportation, environment, and public services are the major factors affecting housing price, which contribute a lot of rising housing price in nearby area.

Acknowledgments
This work was supported by the Doctoral Scientific Research Foundation of Lanzhou City University (LZCU-BS2015-10; LZCU-BS2018-16).

References
[1] Zou L L, Yang J, Hu X D. (2013) Research on temporal-spatial changes of urban residential housing price in China: Progress and prospects. Progress in Geography, 32: 1479–1489.
[2] Wang F, Gao X L, Yan B Q. (2014) Research on urban spatial structure in Beijing based on housing prices. Progress in Geography, 33: 1322–1331.

[3] Pang R Q, Zhao Z Y, Wang W, et al. (2013) The spatial layout of residence since the reform of housing system in Changchun. Acta Geographica Sinica, 33: 435–442.

[4] Sun Q, Tang F H. (2015) The comparison of city housing price spatial variances based on spatial expansion and geographical weighted regression models. Geographical Research, 34: 1343–1351.

[5] Wang Y, Fang C L, Sheng C Y. (2013) Spatial differentiation and model evolution of housing prices in Yangzhou. Acta Geographica Sinica, 68: 1082–1096.

[6] Li J, Yang X J, Shu T. (2014) Residential spatial variation characteristics and regional value: A case of 2011 opened commercial residential buildings in Xi’an City. Arid Land Geography, 37: 170–178.

[7] Song Wei X, Liu C F. (2018) The price differentiation mechanism of commercial housing in the Yangtze River Delta. Geographical Research, 37: 92–102.

[8] Gu X, Zhou L Q. (2015) Spatial Differentiation and Influencing Factors of Wuhan's Housing Price Based on GWR Model. Territory & Natural Resources Study, 63–68.

[9] Song W X, Mao N, Chen P Y, et al. (2017) Coupling mechanism and spatial-temporal pattern of residential differentiation from the perspective of housing prices:A case study of Nanjing. Acta Geographica Sinica, 72: 589–602.

[10] Pan J H, Yang L J. (2017) Spatial-temporal differentiation of housing price-to-income ratio at prefecture level cities in China. Arid Land Geography, 40: 1274–1281.

[11] Liu Z G, Zhang Z B, Wang X X, et al. (2014) The distribution of urban living space in Lanzhou and their causes analysis. Journal of Arid Land Resources and Environment, 28: 72–78.

[12] Chen Q, Zhang Z B. (2015) The spatial distribution patterns and influential factors of commodity housing prices in Lanzhou City. Journal of Arid Land Resources and Environment, 29: 44–50.

[13] Li W H, Han H. (2018) Characteristics of commercial residential price spatial differentiation in Lanzhou city. Science of Surveying and Mapping, 43: 45–50.

[14] Hao F L, Wang S J, Feng Z X, et al. (2018) Spatial pattern and its industrial distribution of commercial space in Changchun based on POI data. Geographical Research 37: 366–378.

[15] Li G Q, Jin F J, Chen Y, et al. (2017) Location characteristics and differentiation mechanism of logistics industry based on points of interest: A case study of Beijing. Acta Geographica Sinica 7: 1091–1103.

[16] Li Q, Wang S J, Mei L. (2017) The Spatial Characteristics and Mechanism of Supermarkets in Central District of Changchun, China. Acta Geographica Sinica 33: 553–561.

[17] Anselin L, Bera A K. (1998) Spatial dependence in linear regression models with an introduction to spatial econometrics. Statistics Textbooks and Monographs, 155: 237-290.

[18] Gillen K, Thibodeau T G, Wachter S. (2001) Anisotropic autocorrelation in house prices. Journal of Real Estate Finance and Economics 23: 5–30.