Spatial Analysis of Residential Land Price in Urban Area of Jimo City Based on GIS

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Abstract. In this paper, land prices of the 234sample points are chosen from the collected bargaining points in Jimo city by using the approaches of market comparison, residual and income. Then, SPSS is applied to carry out normality tests of the sample data and eliminate the outlier data. The trend of land price and spatial interpolation of remaining sample data are depicted with the help of GIS, respectively. The results show that apart from the forth level land, the land price of total samples follows normal distribution, and it is more realistic to use the combination of Q-Q figure and level grading to eliminate the abnormal points. Meanwhile, the spatial distribution of residential land price basically follows the rules that the land price decreases from the city center to the outside area. It is the highest in the city center. Moreover, the land price changes slower in the latitudinal direction than in the longitudinal direction, and both of them follows quadratic parabola. The obtained results conform with the reality in Jimo city, which can be helpful in the management of estate price to avoid malicious overestimation or underestimation.

Introduction

There are many research works concerning the spatial analysis of land price in the urban areas. Zhang has applied the inverse distance weight (IDW) method to analyze the spatial evaluation of benchmark land price in Lodi city [1]. Yang has conducted the research of the feature and measurement of the land price in Jiangsu province [2]. GWR model has been used to analyze the spatial changing characteristics of the land price in urban residential area in [3-5]. The spatial distribution and influences factors of urban land price are studied in [6-8]. However, few research works have applied the method of eliminating the outlier data. In this paper, we will use the data of the transaction of residential and commercial houses in the past 10 years. Then, we apply SPSS to test its normality and GIS to carry out spatial analysis. Thus, the spatial changing characteristics of the residential land prize in Jimo city are discussed.

General Introduction of the Researched Area. Jimo city is located at the shore of Yellow Sea and the Southwest of Shandong peninsula. There are one provincial economic development zone, one provincial hi-tech development zone, and one provincial tourism resort. It has been named as the Model city of National Environmental Protection, the Chinese Outstanding Tourism City, National Technology Advanced City, and Civilized City of the Province. In the economic report of Chinese counties of 2015, both of the economy competitiveness and development potential of Jimo city ranked the 1st in the province, and the 13th and 12th in China, respectively. The rapid development of Jimo city requires the guarantee of residential area, which provides suitable data sources for our researches. Our research area is the main area of Jimo city, including Tong-Ji block, Huan-Xiu block, all parts of economic development district, Long-Quan block, Bei-An block, and most parts of Da-Xin town. The area of the land is 281.4 km^2.

Data Source. The data comes from the following three ways. The first one is the related statistic accounts provided by bureau of land resources in Jimo city. The other one is from websites of

governments and major real estates, such as Ministry of Land and Resources. The last one is from transaction and renting data of houses in every single community. The types of sample points include land transaction, house renting, and house transaction. The time scale of land transaction lands is from January 2007 to May 2016, and that collected data of house renting and house transaction is from the last three years. We used GIS to establish database of sample points. 234 sample points were collected by overlapping boundaries of research areas, and picking off sample points out of

Calculation and Verification for Land Price of the Sample Points

Calculation of Land Price. Different approaches are carried out to determine the land price.

Market. Comparison Approach By using market comparison method, price of land transaction is corrected to get land price as follows：Land price = Land price of land transaction ×Correction factor of transaction date×Correction factor of transaction statement×Yearly revised correction factor.

Income.capitalization method House renting contains renting of land-use right and house-use right. The income from renting of house and land is actually the total income from house and land. By removing total cost of renting and income from house from total income, land net profit is calculated. Using income capitalization method could get us to land price as follows

$$V = \frac{a}{r_1} \times \left[1 - \frac{1}{(1+r_1)^n} \right] \tag{1}$$

where V , a , r_1 and n denote the total income, net profit, land discount rate, and the land use term.

Residual. Approach By removing present value of house and taxes of transaction from transaction price of house, land price of house transaction is calculated as follows: Land price = Transaction price – Land development fee – Building cost – Management expense – Interest of investment – Sale taxes – Development profit.

Normality Tests of the Sample Data. Total statistic analysis of land price of sample data in residential area: We use SPSS to accomplish descriptive analysis and probability analysis for 234 sample points, the results of which are shown in Table 1 and Fig. 1. The difference between maximum value and minimum value is 2789 Yuan/m^2, skewness is lower than 0.5, and kurtosis is equal to 0. Though land prices differ greatly, distribution of sample data is normal distribution, which can be seen from Fig. 1.

Table 1. Statistics of the residential land price.

Number of valid samples	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
234	85	2871	1172.19	623.314	0.250	-0.598

Non-parametric test. We use SPSS to accomplish normality test for 234 sample points, including total test and classification test. The results of tests are shown in Table 2. Except for the fourth level land, the significant levels of total test and the other three levels tests are all below 0.05, which means they follow normal distribution. Geographic information system can be used to finish spatial analysis.

Table 2. Normality tests for the land price.

Shapiro-Wilk	Land level				Sum
	1	2	3	4	
statistics	0.969	0.920	0.950	0.900	0.978
df	129	47	54	4	234
Sig.	0.004	0.003	0.024	0.432	0.001

Q-Q Figure.We use SPSS to draw Q-Q Figures for 234 sample points, as shown in Fig. 2. The x axis is the quantile of standard normal distribution, and the y axis is values of sample points. Q-Q

figures can help us to judge whether data complies to standard normal distribution. Data points in standard Q-Q figure greatly overlap with a straight line, which proves that it complies a normal distribution. The slope of the line stands for standard deviation, and intercept is for mean value.

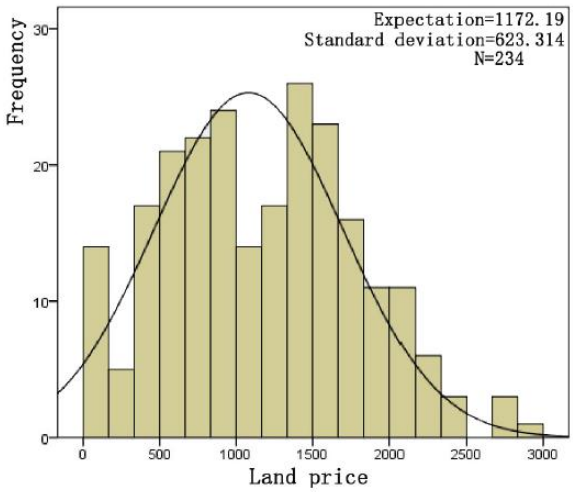


Fig. 1. Histogram of land price.

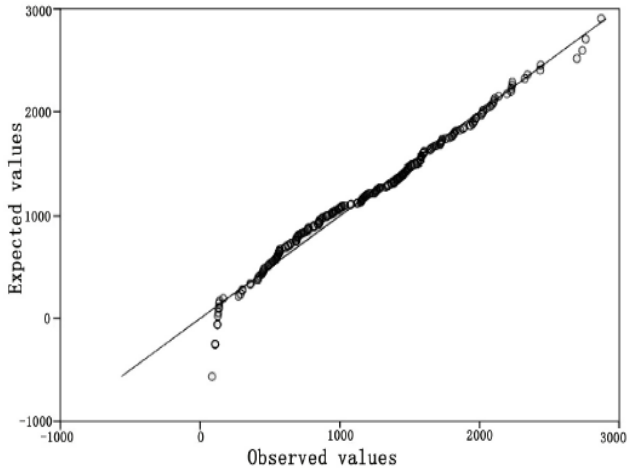


Fig. 2. Standard Q-Q figure.

Elimination of the Outlier Data. According to Q-Q figure of land price, abnormal points can be found. It can be seen from standard Q-Q figure that sample points with land prices over 2500 or 400 Yuan/m^2 deviate the straight line, which means they are abnormal points. 26 points are removed by this method.

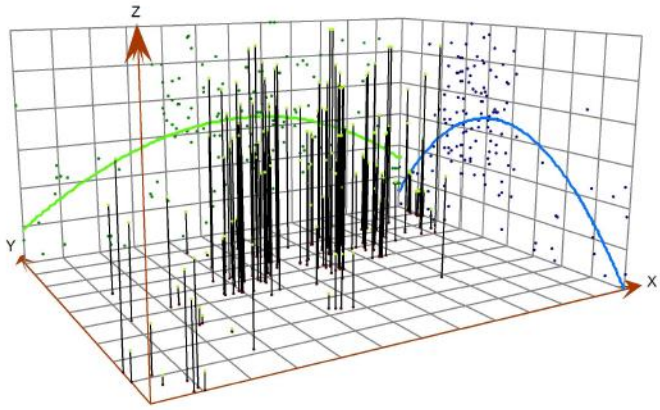
According to distribution of sample points from each level, abnormal points can be found. First, points from the fourth level are collected from edges in city, which means the chance of transaction is low. In our research, only 4 points were collected. They can't stand for a trend, thus have been removed. Second, we use SPSS to summarize maximum land price of each level, and the result is shown in Table 3. Sample points with low land prices are found in area of high level, and those with high land prices are found in area of low level. There are 52 points meet the description above. There are 26, 17, and 9 points found in level one to three, respectively. Although the points follow normal distribution, they are apparently abnormal considering actual conditions. These points need to be removed.

Table 3. The land price of the abnormal sample points of different levels (Yuan/m2).

Land level	Benchmark land price	Maximum	Minimum	Sample points
1st	1277	NaN	412-648	26
2nd	947	2018-2050	85-423	17
3rd	732	1387-1729	NaN	9

Regional Land Price Spatial Variation Analysis of Residential Land

Trend Chart and Spatial Interpolation Chart. We use trend analysis method of GIS to process the left 152 sample points. A trend chart is got by choosing land price as parameter, as shown in Fig. 3, in which the positive value of x axis means east, the positive value of y axis means north, and z axis is the corrected land price of residential area. We use the 152 sample points to make a interpolation chart. Kriging method and inverse distance weighted method are used to analyze the interpolation chart. By comparing, we find that the result of inverse distance weighted method is the most appropriate, as shown in Fig. 4.



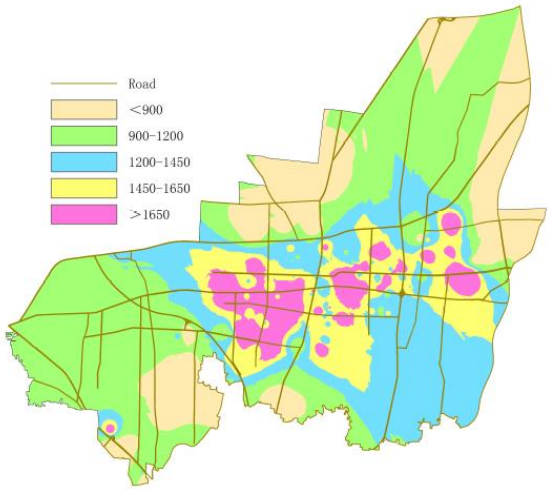


Fig. 3. Tread chart for the land price of Jimo city. Fig. 4. Spatial interpolation chart for the land price of Jimo city.

Spatial Analysis of Residential Land Price. In Fig. 3, land price decrease progressively from the center to the edge, and the rate of decreasing is lower along the east-west axis, compared with that along south-north axis.

The cross-section along east-west axis shows that land price decrease progressively from the center to the edge. Land price in the edge of west is much lower than that in the edge of east. The main reason is that Chuang-Zhi new district develops fast in Jimo city. In this district, the environment is perfect, the infrastructure is complete, and it is near the Blue Silicon Valley. The cross-section along south-north axis shows that land price decrease progressively from the 5/9 area from south to the edge. Land price in the edge of south is much lower than that in the edge of north. Though the trend of land price along two axis is parabola with low slope, the slope of south-north is much greater than that of east-west. What's more, the points of maximum value are different. The main reason is that the main development direction is along east-west axis. Lan-Ao road along with He-Shan road are surrounded by business districts, advanced residential cells, infrastructures, and public service facilities.

In Fig. 4, the spatial distribution of land price in Jimo city basically obeys to the regularity that it decreases progressively from the center to the edge.

Along Lan-Ao road and He-Shan road, three districts have high land price over 1650 Yuan/m2. One of them is pretty big and the others are small. The highest price area appears in the center of Jimo city, which includes center business district and western business district. The second and third highest price areas appear in the east, which includes eastern business district and Chuang-Zhi new district. Areas with land prices of 1450-1650 Yuan/m2, 1200-1450 Yuan/m2, 900-1200 Yuan/m2, <900 Yuan/m2 are called second high land price districts, middle land price districts, second low land price districts, and low land price districts, respectively. These districts are around the mentioned three high land price districts.

Conclusion

We take the main urban area of Jimo city as the research of interest. Land prices of the 234sample points are chosen from the collected bargaining points in Jimo city by using the approaches of market comparison, residual and income. Then, normality tests of the sample data is carried out and then the outlier data is eliminated. The trend chart of the land price and the spatial distribution model are established with the help of GIS. The results are as follows: (1) even though the land price of total samples follows normal distribution, sample data from a certain area may not pass the normality test, e.g., the land of the 4th level. (2) If we only use Q-Q figure to eliminate the abnormal points, some lower points may appear in the district of 1st and 2nd level, and some higher points may appear in the district of 2nd and 3rd level. It is more realistic if we combine the land level and Q-Q figure to eliminate the abnormal points. (3) The spatial distribution of residential land price basically for the rules that the land price decreases from the city center to the outside area. It is the highest in the city

center. Moreover, the land price changes slower in the latitudinal direction than in the longitudinal direction. The obtained results conform with the reality in Jimo city, which can be helpful in the management of estate price to avoid malicious overestimation or underestimation.

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