Spatial Differentiation Patterns of Housing Price and Housing Price-to-income Ratio in China's Cities

Yang Wang[1,2], DeliWang[3]*, Ye Wei[4]
[1]Institute of Geographical Sciences and Natural Resources Research,
Chinese Academy of Sciences, Beijing, China
[2]University of Chinese Academy of Sciences, Beijing, China
[3]Beijing Academy of Social Sciences, Beijing 100101, China
[4]Department of Geography, Northeast Normal University, Changchun 130024, China
*Corresponding author, e-mail:wangdl562@163.com

Abstract—**Based on the basic data of the housing price and housing price-to-income ratio in 286 prefecture-level cities in 2009, this paper analyzes the spatial differentiation pattern, overall trend, spatial heterogeneity and correlation between the absolute housing price and relative housing price. The results show that: 1) there is significant spatial differentiation in terms ofChina's urban housing price, and the distribution presentsdual patterns of spatial clustering differentiation (the three southeast coast urban agglomerationsversusinland cities) and administrative level differentiation (between provincial capital and prefecture-level cities). 2) The overall differentiation trend and spatial heterogeneity of absolute housing price are higher than that of the relative housing price.**

Keywords-housing price; housing price-to-income ratio; spatial differentiation; semivariagram ; China

I. INTRODUCTION

In times when China has high housing prices, the housing price has become the core issue that the government and inhabitants pay close attention to. It is also the key problem related to social fairness and stability, the development of human living, the improvement of household happiness, the building of harmonious society, the improvement of urbanization quality, and the healthy development of real estate market. Recent years, scholars has gradually paid attention to the differentiation of housing price among different cities in China [1-7]. For example,the average housing price of Wenzhou, which has the highest urban housing price in China, is 20 times the housing price in Longnan (at the end of 2009). High housing prices has become a major resistance in talent attraction. The famous phenomenon of "escaping from Beijing, Shanghai and Guangzhou" is closely related to housing price differentiation. Present, related research normally use a sample of 35 large cities[2-5]or 30 provincial cities[6, 7], but previous researches seldom used large samples that include 'third-level cities', not even to mention analyzingthe spatial differentiation of urban housing price in China from a geographic perspective.

Therefore, it is essential to explore the spatial differentiation of housing price based on a large sample that includes more cities' data. This is helpful in analyzing the spatial structure of the Chinese regional residential market. Moreover, it has reference meaning for policy making of regional residential development strategy and also has practical significance for the government in adapting to local condition in order to implement a diversification strategy. Residents' enduranceto housing price varies with household income level. Therefore, it will be of practical significance to calculate relative housing price based on household income. 'Housing price-to-income ratio' is the common concept[8, 9]of evaluating whether the housing price is reasonable or not. Recent academic researchers have paid more attention to the reasonability of housing price-to-income ratio and the comparison study of both Chinese and foreign housing price. However, there is little research on the differentiation of urban housing price. Hence, it will be of practical significance to analyze the spatial differentiation pattern of urban relative housing price based on housing price-to-income ratio considering the significant regional differentiation of housing price-to-income ratio.

This paper chooses 286 prefectural level cities as analysis units. The overall differentiation trend, spatial heterogeneity and spatial correlation of housing price will be investigatedin this paper. It has new progresses both on sample depth and research perspective.

II. DATA AND METHODS

A. Study Areas and Data Sources

This paper uses the downtown of 286 prefecture level cities as study units except Lhasa, Hong Kong SAR, Macao SAR, Taipei and Kaohsiung. It uses housing average prices and housing price-to-income ratios as basic research indicators and considers 38 indicators such as disposable income per capita of urban resident as impact factors evaluation collection (11440 data points in total). Housing price data were obtained fromChina

Supported by the National Natural Science Foundation of China (No.41201154)

Urban Life and Price Yearbook (2010), impact factors data were obtainedfrom China Urban Construction Statistical Yearbook (2009), China Land & Resources Almanac Statistics Yearbook (2010), China Environment Yearbook (2010), China City Statistical Yearbook(2010),China Statistical Yearbook for Regional Economy,China County Statistical Yearbook(2010),China Statistical Yearbook(2010),Statistical Yearbook of the Chinese Investment in Fixed Assets(2010).

B. Calculation Method of Housing Price

1.Absolute housing price represented by average price

The housing average price can be calculated according to the sales volume of commercial houses and sold areas of commercial houses. It is defined as:

$$p_i = B_i / S_i \tag{1}$$

where pi is the average housing price of the ith city, which is the absolute housing price; Bi and Si is sale volume and sold area of commercial houses of the ith city respectively.

2. Using housing price-to-income ratio to capture relative housing price

The "Urban Indicators Guide", published by the United Nations Human Settlement Center, believes housing price-to-income ratio is the ratio between the moderately free market price of residential unit and medium household annual income [11, 12].This guide uses diversified measurement methods to analyze the ratio relationship between typical housing price and typical household income. In domestic practice, researchers always adopt the 'ratio between average housing price and average household income per capita' as the housing price-to-income ratio[13] given the difficulty in calculation. But there is still no common calculation method[9]. In this paper, assuming there is no other consumption; urban housing price-to-income ratio of one city is the number of years it takes for a family with medium income to buy a medium size residence using all their disposable income without a bank loan. This value represents the relative housing price and average difficulty of purchasing a house in one city. The calculation steps are as follows:

① The cost to buy a medium size house of one family:

$$H_i = s_i r_i p_i \tag{2}$$

② The average family annual income is:

$$F_i = I_i r_i \tag{3}$$

③ The relative housing price (price-to-income ratio):

$$C_i = H_i / F_i \tag{4}$$

Therefore, the urban relative housing price can be expressed as:

$$C_i = s_i p_i / I_i \tag{5}$$

Where, Ci is the relative housing price of ith city, which is the housing price-to-income value. The higher the relative price is, the larger Ci will be; Si is the per capita construction areas and is 31.3m2 according to China Statistical Yearbook (2011); pi and Iiarethe average housing price and per capita annual disposable income of urban household of ithcity respectively; riis the average family size.

C. Spatial Statistical Analysis of Housing Price

1. The overall trend of spatial differentiation using trend surface analysis

This paper uses trend surface analysis to do a semi-quantitative study of the geographic data with a relatively wide spatial span[14]. Trend surface can simulatethe spatial distribution and changing trend of geographic factors[15]. It is the approximate value of the actual surface. This paper adopts trend surface analysis to abstract the overall trend differentiation of housing prices in urban China. Consider Zi(xi , yi) asthe ith city's housing price. xi, yi are the flat space coordinates. According to the definition of trend surface, Zi(xi , yi) can be written as equation (6):

$$Z_i(x_i, y_i) = T_i(x_i, y_i) + \varepsilon_i \tag{6}$$

WhereTi (xi , yi) is trend function and represents a wide range of trend values. εiis the autocorrelation of random error and represents the deviation between the real housing price and trend value of the ith city. This paper adopts a second order polynomial to capture trend value, and the trend value can be expressedasequation (7)[16]:

$$T_i(x_i, y_i) = \beta_0 + \beta_1 x + \beta_2 y + \beta_3 x^2 + \beta_4 y^2 + \beta_5 xy \tag{7}$$

2. Semivariogram analysis of spatial differentiation and correlation analysis

The semivariogramis an important tool in analyzing the spatial differentiation and correlation analysis in the field of geographic study. It also can describe the randomness and structural features of regional variables. Semivariogram curve represents the spatial relationship between two adjacent sampling points. The semivariogram of housing prices can be expressed as:

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} \left[Z(x_i) - Z(x_i + h) \right]^2 \tag{8}$$

where, γ(h) is the semivariogram, h is the distance between adjacent cities, N(h) represents the number of adjacent cities that has the distance of h. Z(xi) and Z(xi+h) are the observations of regional variable Z(x) at space location of xi and xi+h. The parameters of semivariogram have sills (C0+ C), range(A) and nugget (C0) (Fig.1). The sills refer to the vertex that the semivariogram can reach. Range is the distance when the semivariogram reaches to the sills, which is autocorrelation threshold.

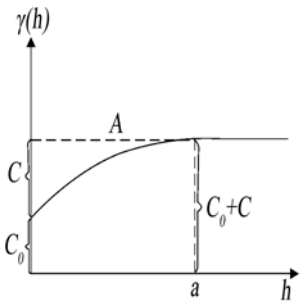

Figure 1. The model of semivariogram

III. The Spatial Differentiation of Urban Housing Prices in China

A. *The Spatial Differentiation Pattern and Classification of Absolute Housing Price*

According to the arrangement regulation of housing prices in each Chinese city in 2009 and referring to the result of cluster analysis, there are 179 cities (the largest number) with housing prices between 2001 and 4000 yuan/m2,which are defined as cities with medium housing price; there are 43 low housing price cities with 2000 yuan/m2; the number of high housing price cities with over 4000 yuan/m2 is 64. Among all these cities, 22 cities' housing prices are over 6000 yuan/m2 which is defined as extremely high housing price. Four first-tier cities (Beijing, Shanghai, Guangzhou, Shenzhen) and three coastal cities (Hangzhou, Wenzhou and Sanya) have the highest housing prices that are more than 10000 yuan/m2 inChina.

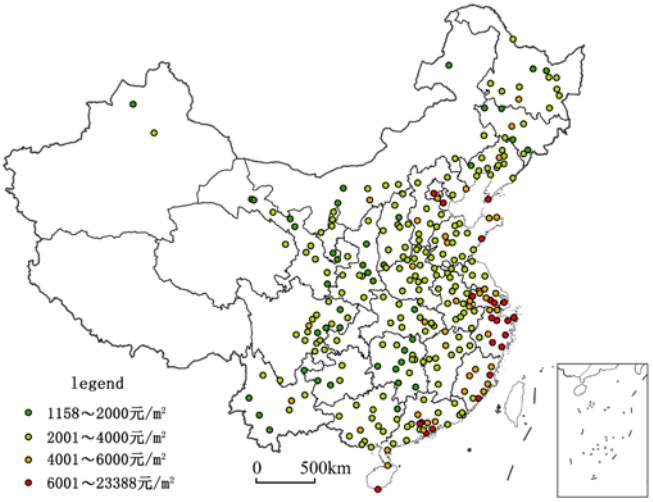

Figure 2. The spatial pattern of housing prices in China's cities

Fig.2 is given based on the classification above. As shown in Fig.2, the spatial pattern of housing price of urban cities in China presentspatial aggregation and administrative hierarchical features. Spatial aggregation feature is represented by the fact that high housing price cities are located mainly in the three major southeast coast agglomerations–Yangzi River delta agglomeration, Pearl River delta agglomeration and west coast urban agglomeration. Cities with medium and low housing price are mainly located in inland areas. Administrative hierarchical feature is illustrated by the fact that high housing price cities are mainly located in provincial cities (including municipalities and vice-provincial cities) and shows a point-like distribution. Most of the cities with medium and low housing price are prefecture level cities. The overall spatial pattern shows that the housing price differentiation coexists between three southeast coastal urban agglomerations and inland cities, as well as between provincial cities and prefecture cities.

B. *Spatial Differentiation Pattern and Classification of Housing Price-to-income Ratio*

This paper captures relative housing prices and makes a histogram according to the formula of housing price-to-income ratio (Fig.3). This graphreveals thatthe degrees of difficulty of purchasing a house among different cities in China differ greatly. The residents in Wenzhou would need 29.92 years to buy a house with average area of 31.2 m2 per person without any other consumption. However, residents in Tongchuan who have medium level income would only need 2.75 years to buy a house. If considering other daily consumptions like food, living, health care, and transportation consumptions, the differentiations would be even more obvious. Based on former international studies, the reasonable range of housing price-to-income ratio is between 4 and 6 for developing countries[11]. According to this international experience value, this interval is considered as the medium level price-to-income ratio in this paper. Ratios less than 4 aredefined as the low price-to-income ratios and the values larger than 6 arethe high price-to-income ratios. Moreover, value larger than 10 areconsidered as extreme high price-to-income ratios. The spatial pattern graph is drawnbased on these price-to-income ratio levels.

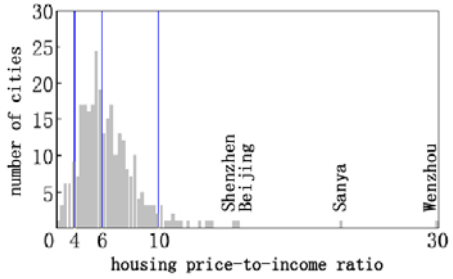

Figure 3. The histogram of housing price-to-income ratio in citiesof China

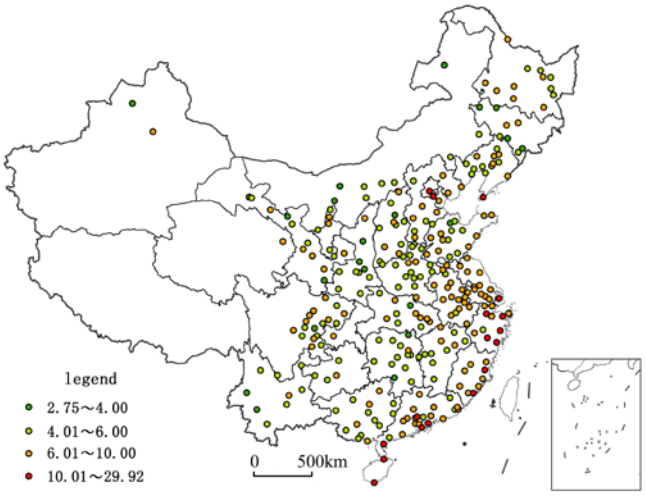

Figure 4. The spatial pattern of housing price-to-income ratio in cities ofChina

As shown in Fig.3 and Fig.4, the number of cities with high price-to-income ratio is larger than that with low price-to-income ratio. In the end of 2009, there are 145 cities with house price-to-income ratio larger than 6, which account for 50.69% of the total number of cities. This indicatesthat it is difficult to buy a house for residents in more than half of the cities in China. Among these cities, there are 17 cities with house price-to-income ratio larger than 10. Wenzhou (29.92), Sanya (22.92), Beijing (15.76), and Shenzhen (15.40) are the four cities with highest degree of difficulty; other 13 cities (Hangzhou, Shanghai, Lishui, Fuzhou, Dalian, Guangzhou, Ningbo, Haikou, Xiamen, Langfang, Zhanjiang, Taizhou, Zhuhai) also have extremely high price-to-income ratios. These cities are all coastal cities except Beijing and Langfang. There are up to 128 with high house price-to-income ratio. These cities are located both in coastal and inland areas and mainly located in Guangdong, Fujian, Zhejiang, Jiangsu, Hebei, Anhui, Hubei, Sichuan, and Heilongjiang provinces. Therefore, although cities with high absolute housing price mainly located in coastal areas and the number is relatively small, there are a large number of cities with high relative housing prices that are located in coastal and inland areas. There are 119 cities with medium house price-to-income ratio and takes up 41.61%; these cities are mainly located in inland areas. There are only 22 cities that have low house price-to-income ratio and mainly distributed in the western provinces and northeast provinces. The number of cities with relative medium and low housing prices is much smaller than that with absolute medium and low housing prices.

C. Comparison of Spatial Differentiation Pattern Between Absolute Housing Price and Relative Housing Price

1) Comparison of overall differentiation trend

Fig.5 is the overall trend surface analysis graph that illustrates the urban absolute housing price and relative housing price in China. As shown in Fig. 5, the overall trend shows spatial pattern of high housing price in the eastern and southern areas and low housing price in the western and northern areas. And the eastern-western differentiation is higher than southern-northern differentiation in absolute housing price. The main direction of differentiation of relative housing price is significant between the western areas and east areas, and the degree of southern-northern differentiation is not significant and also weaker than that of the absolute housing price differentiation. From this result, we find that the spatial differentiation of urban absolute housing price in China is mainly between the eastern areas and the western areas. Meanwhile, the differentiation degree of absolute housing price is higher than that of the relative housing price.

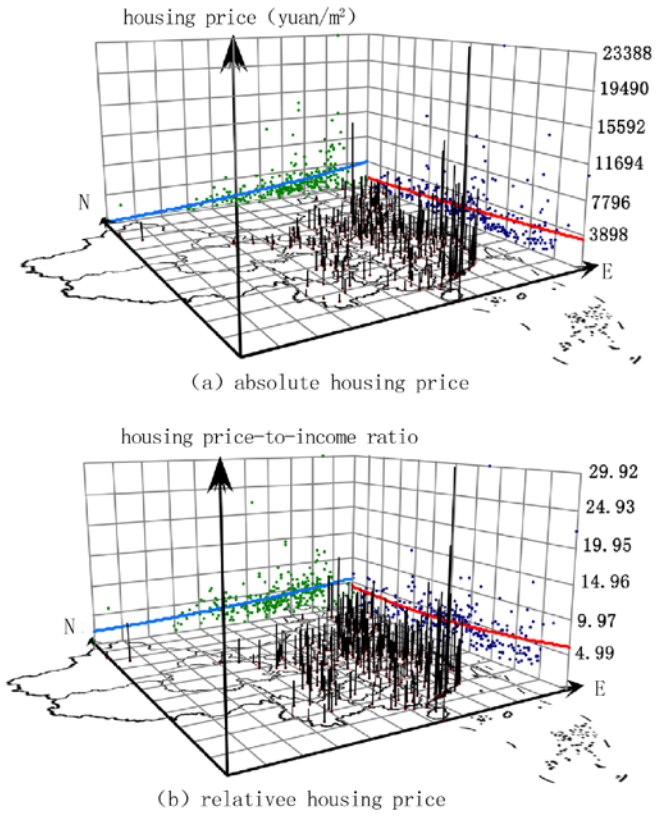

Figure 5. Contrast of global trend between housing pricesand housing price-to-income ratioin terms of spatial differentiation in cities of China

2) Comparison of spatial heterogeneity and correlation

The estimated error would be increased if using sample data with abnormal distribution which could lead to excessive fluctuation of the variogram. Therefore, it is essential to examinethe normal distribution of sample data and performdata transformation before building the variogram model and spatial statistic analysis [17]. The housing price of Wenzhou was eliminated as outlier because the value is too far away from the others. According to the description statistics analysis of urban housing prices, the skewnessvalue of absolute housing price is 2.7862 and it haspositiveskewness. After processing the samples by logarithmic transformation, the skewness value decreased to 0.9771, the average value and median value arealmost the same and obey the normal distribution.

Similarly, the skewnessvalue of relative housing price data is 0.4716 after the logarithmic transformation. The average and median value are close to each other; hence the relative housing price data sample obeys the normal distribution. After the logarithmic transformation for the two data samples, the semivariogram will be calculated. The lag size is set for190km and number of steps is 10 in order to make sure that the steps multiply the number of steps equals approximately to 0.5 times of

the largest distance between cities. The variogram can only be estimated based on sample data given that the theory variogram is unknown. This paper uses second order of trend method of Universal Kriging and adopts the Sphere model, Exponential model, Linear model, and Gaussian model to do the fitting. In the end, the model with highest fitness will be chosen and the semivariogram will be described. The model and fitness results are shown in Fig. 6.

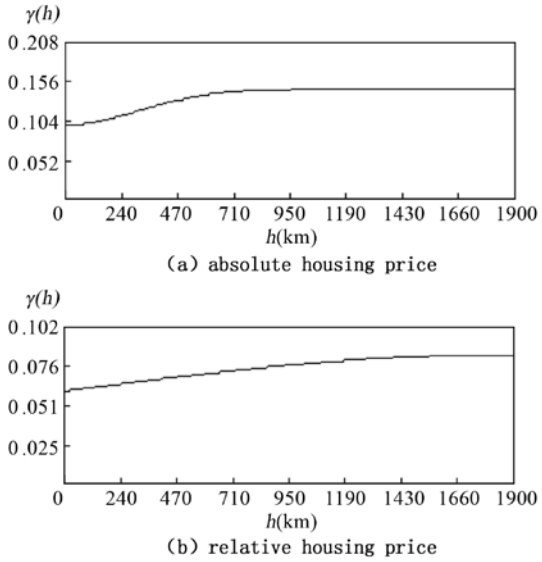

Figure 6. The semi-variant of housing prices in China's cities

Result shows that the sill value of absolute housing price is obviously higher than that of relative housing price. This illustrates the overall spatial differentiation degree of absolute housing price is higher than that of relative housing price. Moreover, the differentiation of relative housing price is less significant than that of absolute housing price considering residents income. This result is in accordance with the spatial pattern in Fig. 2 and Fig.4,and is also in line with the overall trend of Fig. 5. The nugget coefficient values of both absolute and relative housing prices are above moderate value, this illustrates the housing prices among each city have below moderate spatial correlation. The reciprocity and linkage effects of housing price among Chinese cities are not significant toprove the coexistence of both spatial aggregation pattern and administrative hierarchical pattern. Most of the cities' housing prices shows administrative hierarchical pattern except the three major southeast costal agglomerations. Meanwhile, the housing spatial differentiation caused by random components (urban internal factors) is stronger than the effects of structural components (regional development factors). The range value of relative housing price is higher than that of absolute housing price. Although there is no significant spatial correlation between relative and absolute housing prices, the influence sphere of spatial correlation of relative housing price is wider than that of absolute housing price due to the high correlation of residents' income.

IV. Conclusions and Discussions

(1) There is significant differentiation among China's cities in housing prices. The price differentiation shows dual patterns which are spatial concentration differentiation pattern (between the three southeast coast urban agglomerations and inland cities) and administrative hierarchy pattern (between provincial cities and prefecture-level cities). The number of cities with high relative housing prices is larger and the distribution range is wider than that of absolute housing prices. The number of cities that are relatively difficult to buy a house is more than half of China. This shows that although the absolute housing prices in some inland cities are not high, the housing prices are still 'seemed to be extremely high' for the residents considering their income level. This also indicates the large difference between the spatial pattern of absolute housing price and relative housing price.

(2)The overall trend of absolute housing price differentiation shows the housing price is mainly higher in eastern areas and lower in western areas, it also supplemented by the trend of high housing price in southern areas and low housing price in northern areas. Relative housing price differentiation only demonstratedthe trend of high price in eastern areas and low price in western areas. Moreover the differentiation degree of relative housing price is weaker than that of absolute housing price. Both absolute and relative housing prices have medium weak spatial correlation and the interaction and linkage effects of housing prices are not significant between each city. Furthermore, the influence effect of urban internal factors on housing price differentiation is stronger than regional development factors. The overall spatial differentiation of relative housing price is less significant compared with the differentiation of absolute housing price, but the influence sphere of the spatial correlation of relative housing price is wider than that of absolute housing price. Overall, the spatial differentiation degree of urban relative housing price is more 'mitigatory' than that of urban absolute housing price.

The result in this paper is different from previousresearches because this study captures a large sample of all the prefecture-level cities' data and the screening of core impact factors comes from the impact factor system that includes more than 38 indicators. The research process is more comprehensive and objective than a priori type calculations that select a small number of factors. Additionally, the calculation of the index values of various impact factors is based on the geographic scope of the urban or built district and also takes the effect of urban temporary population into account. This is more reasonable compared with the method based on statistics of administrative region and household population.

Acknowledgment

The authors would also like to express appreciations to colleagues in our laboratory for their valuable comments and other help.

REFERENCES

[1] M.He, S. Z. Ke, andH. Wen. "Amenities and regional differentials of real estate prices in Chinese cities," The Theory and Practice of Finance and Economics, vol.30(2), 2009,pp.97-103.

[2] J. F. Zhang and H. Y. Liu. "The determinants of inter-metropolitan variation in house prices and land prices,"Statistical Research, vol.27(3), 2010, pp.37-44.

[3] S. Q.Zheng, Y.Cao, and H. Y.Liu. "The value of a city and its house price: an empirical study across 35 Chinese cities," Urban Studies,vol.15(1), 2008, pp. 4-7.

[4] X. Z.Dai and N.Ma. "The influence and spatial distribution of demand and supply factors on urban commodity housing price," Urban Studies, 17(10), 2010, pp.46-49.

[5] X. P.Fang and S. B.Ding. "Geographical spread of urban house price in china and its regional externality," Scientia Geographica Sinica, vol.32(2), 2012, pp.143-148.

[6] X. M.Cui. "Analysis and empirical study of the dynamical factors affecting urban house price level," Hangzhou: Zhejiang University, 2003.

[7] B.Guo. "Housing Supply System and Trend of Price Variation," Xi'an: Xi'an Jiaotong University Press, 2010.

[8] M. C.Chen, I. C.Tsai, and C. O.Chang. "House prices and household income: Do they move apart? Evidence from Taiwan," Habitat International, vol. 31(2), 2007, pp.243-256.

[9] Z. L. Zhang and Y. S. Zhang. "Present situation, trend, and regulation of house price in metropolis on the basis of price-to-income ratio: A case study of Beijing," China Price, (4)2011,, pp.54-58.

[10] Z. X. Zhuang. "A study of price-to-income ratio and reasonable house price," Market Economy & Price, (8) , 2010, pp.4-6.

[11] Z. Wang. "Calculations of reasonable house price based on price-to-income ratio," Price: Theory & Practice,(9) , 2007, pp.49-50.

[12] H. Zheng, X. H. Wu, and Q. B. Nie. "The improvement and empirical study on calculating method of price-to-income ratio——a case study of Nanjing city," Price: Theory & Practice,(9) , 2010, pp.35-36.

[13] D. Y. Su and Z. G. Zhang. "The improvement of studies on price-to-income ratio," China Real Estate, (4) , 2009, pp.14-16.

[14] J. C. Dornkamp. "Spatial Analysis in Geomorphology," Harper & Row Publishers, 1972.

[15] J. H. Xu. "Mathematical Methods in Modern Geography (The Second Edition) ," Beijing: Higher Education Press, 2002.

[16] Q. Wu and H. Q. Gao. "Analysis on the mechanism of suppl-demand to the price of commercial housing in metropolis——a case study of Nanjing city," China Land Science, vol. 20(2) , 2006 , pp.51-56.

[17] Z. X. Mei. "Spatial heterogeneity analysis of houses'prices based on semi-variogram: taking Dongguan city as a case," Journal of South China Normal University (Natural Science Edition), (4), 2008, pp.123-128.