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Paper Title: The Effect of Spatial Diversity on the New Properties Price in Hangzhou under the Housing Market Regulation - An Empirical Analysis Based on POI Data

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Extended abstract

Abstract: Facing soaring housing prices, a new return of strict market regulatory measures has been implemented by the Chinese government since 2018. The municipal government of Hangzhou also released a lottery policy on new properties market armed to curb its surging housing prices. Based on the POI data in Hangzhou, this paper uses the count model to obtain the number of POI distribution points within 2 km scope of different lottery properties in the metropolitan areas since 4th April 2018, proposes three methods using OLS, GWR and Kriging interpolation method to empirically study the spatial influential factors on the new properties’ prices under the administrative interventions as well as purchase restrictions.

Keywords: Spatial diversity, Price regulation, the lottery of new properties; POI

Introduction

Since the recovery of the Chinese real estate market in 2016, the housing prices in Hangzhou which as the capital of Zhejiang Province and the city hosted the G20 summit has been Soaring. The serial surging housing prices and rising serious household indebtedness are the vehicles through which macroeconomic policy works?. However, with the accelerated accumulation of debt and credit risk in recent years, the Chinese government is increasingly worried about the housing bubble which could induce a systematic financial crisis. In order to govern the housing prices, the renewed regulatory policy on housing prices has been issued from the central government to the local government. Hangzhou is an attractive city in the urban agglomeration of the Yangtze River Delta in eastern China. With the continuous development of urbanization level, at present there is over ten million people in Hangzhou after 2018. The concentration of the population and the promotion of the industry have stimulated the housing demand of the city. From 2016 to 2017, housing prices in Hangzhou almost doubled, so that the government had to carry out new regulatory measures to control as well as guide its real estate market to make new properties affordable to larger numbers of homebuyers. In order to stabilize housing prices, in April 2018, a new policy-Lottery policy was carried out by the Municipal Government of Hangzhou, which can also be considered as a price control policy. It set up a price ceiling which makes the price control on new apartments and restricted the number of houses purchased. People who without or only have one property can purchase a new house, but they must participate in the lottery activity. As of April 4, 2019, Hangzhou issued the lottery policy for the whole year. In the year, a total of 247 properties received 702 pre-sale permits, a total of more than 92,000 suites were launched,
and more than 620,000 people participated in the lottery. The newly introduced notarization policy can make the price of new houses not be interfered by an extra cost, such as unspoken regular service charge. It can also carry out differential regulations to ensure the rigid demand, alleviating the purchase cost and life pressure of buyers, so that the just needed crowd can get the house in a fairer way. Besides, this policy can also reject housing investors. Then, in the context of the government's price regulation, the performance of new property prices is worth studying.

1 Theoretical background

As a heterogeneous commodity, a property is made up of a series of different residential characteristics, while the characteristics of these products will influence the choice of consumers. Residents' consumption of a property is achieved through consumption of residential characteristics (LANCASTERKJ.1966). The price of urban housing is spatial data which is closely related to the spatial location. Geographical factors such as location conditions, traffic conditions, infrastructure, and environmental conditions will have different effects on the housing price. Wen (2010, 2011) showed that the property price has significant spatial effects through empirical research. At the same time, the spatial diversity between the distribution of residential characteristics and the degree of impact on residential prices leads to the spatial diversity of urban residential prices. With the development of Geographic Information Systems (GIS), ArcGIS brings convenience to extract spatial information, which was widely used in the study of the spatial distribution characteristics of property prices. If the study combines the geographic model with the hedonic price, the impact of residential characteristics on the spatial diversity of housing prices can be understood in a deeper and more comprehensive way. The point of interest (POI) mainly refers to some geographical entities that closely related to people's lives, such as schools, banks, supermarkets, etc. Obtaining POI data is relatively easy, which has high coverage of public service facilities and the data has broader coverage. In other words, POI describes the spatial and characteristic information of these geographic entities, such as the name, address, and coordinates of the entity. The POI data greatly enhances the ability to describe the location of the entity, reflecting the city's activities; and the POI data is time-sensitive. Using POI data can overcome the disadvantages that most of the current specific statistics are insensitive to time in the study.

Using POI can obtain the distribution of commercial facilities, educational facilities and transportation facilities around the residential community more accurately. If the POI data is combined with the housing market, real-time and comprehensive research on the impact of infrastructure spatial distribution on housing prices in Hangzhou can be carried out.

The study aims to address the influence of a large number of spatial factors on housing prices around Hangzhou Real Estate after the implementation of the price regulation. This paper focuses on the POI based spatial analysis and excludes some parameters that have less impact on housing price, such as newsstands, public toilets, etc. The POI data were divided into ten categories - restaurants, living facilities, higher education, basic education facilities, cultural facilities, stores, hospitals, entertainment venues, banks, and transportation facilities, using the count model to obtain the distribution number of these ten types of POI within 2km range around each lottery property. A simple linear regression (OLS), spatial model (GWR) and Kriging interpolation method were used to study the location factors of new housing prices in Hangzhou quantitatively under the price regulation.

2 Research problems

The housing price is spatial data with significant spatial effects. This study aims to address the following questions for POI based housing price spatial analysis:
Abstract proposal for 2017 IGU Urban Commission Meeting Luxembourg - 4th - 9th August 2019

(1) How can POI influencing factors for these ten infrastructures be quantified to evaluate the housing price?

(2) How does the spatial regression model perform? How do the various residential characteristics of residential prices perform based on the GWR model? Furthermore, what is the relationship between correlated spatial characteristics of POI data and the housing price?

(3) The research area selected in this study where the price regulation is implemented in Hangzhou is mainly distributed in the main city areas (Shangcheng District, Xiacheng District, Gongshu District, Xihu District, Jianggan District, Binjiang District) and non-main city locations (Lin'an City, Yuhang District, Xiaoshan District and Fuyang District). Because the number of lottery properties in these two areas differs largely, the group return is not divided into the main city and the non-main city areas. The study only focuses on these areas where the price regulation is implemented in Hangzhou, then what is the impact of various influencing factors on the housing price and what is the spatial variation in terms of influential degrees?

3 Research method

In previous studies, few types of research combined spatial data with the housing price. However, in this study, POI data are applied to the housing price for quantitative analysis. The POI data are obtained from Baidu Map Application Programming Interface (API), abandoning the POI category which has little relationship with the housing price and merging the similarities. According to certain classification criteria and the relevant literature, with using the features of POI data and combining residential characteristics, it is divided into the following ten categories: restaurants, living facilities, higher education, basic education facilities, cultural facilities, stores, hospitals, entertainment venues, banks, and transportation facilities. After the data cleaning, de-duplication, coordinate correction, etc., a total of 19,576 POI data in the study area are extracted, and then use the count model to obtain the number of these ten types distribution of POI within 2km (2km is the maximum walking distance of residents) range around each lottery property. A simple linear regression (OLS), spatial model (GWR) and Kriging interpolation method are employed in this study.

(1) Ordinary least squares (OLS) regression

OLS is introduced to address the influential trend of different types of POI distribution on housing price.

\[
\ln p = v_1 \ln \text{transportation} + v_2 \ln \text{livingfacilities} + v_3 \ln \text{restaurant} + v_4 \ln \text{entertainment} \\
+ v_5 \ln \text{higheducation} + v_6 \ln \text{basiceducation} + v_7 \ln \text{cultural} + v_8 \ln \text{bank} + v_9 \ln \text{store} \\
+ v_{10} \ln \text{hospital} + \delta
\]

In the OLS, where \( \ln p \), the dependent variable, \( p \) is the housing price under the Hangzhou price regulation, in order to make the model more perfect, taking the logarithm of the housing price. Do the same for the explanatory variable, \( \ln \) transportation, \( \ln \) living facilities, \( \ln \) restaurant, \( \ln \) entertainment, \( \ln \) high education, \( \ln \) basic education, \( \ln \) cultural, \( \ln \) bank, \( \ln \) store, and \( \ln \) hospital are the explanatory variables, which are the logarithm of the number of these ten kinds of POI within 2km range of each property, \( \delta \) is the random disturbance.

However, OLS has its drawbacks. It only estimates global parameters rather than local ones. Meanwhile, housing prices are a type of spatial data. If only this method is employed, the spatial location of the sample data of the housing price and the characteristics of a certain part of the study area are not considered.

3
Abstract proposal for 2017 IGU Urban Commission Meeting Luxembourg - 4th -9th August 2019

(2) Geographically weighted regression (GWR)

In different spatial locations, the impact of the housing price has spatial diversity. In the GWR, the spatial position of housing price data is introduced, and the weights are calculated by spatial distances, which can describe the relationship that changes with the spatial position between housing price and influencing factors accurately. To make the model more perfect, the logarithm of the distribution number of POI for restaurants, living facilities, higher education, basic education facilities, cultural facilities, stores, hospitals, entertainment venues, banks and transportation facilities within 2km of each property is applied into the GWR model. For the purpose of studying the spatial diversity of the contribution of these factors to housing price, the relationship between housing price and various spatial factors is analyzed.

\[ y_i = \beta_0(u_i,v_i) + \sum_k \beta_k(u_i,v_i) x_{ik} + \varepsilon_i, \quad i=1, 2, \ldots, n \]

Where \((u_i,v_i)\) is the coordinates of the \(i_{th}\) sample point, \(\beta_k(u,v)\) represents the regression coefficient of the \(K_{th}\) influencing factor of the \(i_{th}\) sample point to the explanatory variable \(y_i\), when \(\varepsilon_i\) is error term.

(3) Kriging Interpolation Method

The same infrastructure has different impacts on housing prices in different administrative regions. In order to analyze the impact of various factors on the spatial diversity of residential prices in various administrative regions where the price regulation is implemented in Hangzhou more intuitively, Kriging interpolation will be employed. The Kriging interpolation method is the one that constructs a spatial structure model around the sample observation points to be predicted, which can quantizes the spatial autocorrelation according to the law between the sample observation points. It provides an optimal linear unbiased estimation method. Firstly, considering the spatial variation of the sample observation points, based on this, a range that has an influence on the interpolation points is determined, and then the attribute value of the point that will be inserted can be estimated. Due to the limited collection of residential price data, only the spatial distribution characteristics of known samples can be analyzed, while the analysis of the spatial characteristics of all housing price samples in the entire study area cannot be done. Therefore, the Kriging interpolation method is adopted. Forecasting the price data of unknown samples through a known amount of housing price data further reflects the spatial distribution characteristics of the housing price samples. According to the analysis results of the GWR model, the Kriging interpolation method is used to calculate the regression coefficient obtained from the GWR model of each influencing factor for each housing price sample to form a spatial graph, and the change of the regression coefficient of the influencing factors and its spatial distribution in the study area is displayed as the form of contours. It enables to analyze the impact of various elements on the spatial diversity of the housing price in Hangzhou under the government price regulation more intuitively and clearly.

\[ Z(x) = \mu(x) + \varepsilon(x), \]

\(Z(x)\) is the regionalized variable of the study area, it presents the housing price of the study area in this paper; \(Z(x)\) can be decomposed into deterministic trends \(\mu(x)\) and random autocorrelation error forms \(\varepsilon(x)\). Where \(x\) is the position vector of the sample in space, it can be regarded as the \(x\) (longitude) coordinate and \(y\) (latitude) coordinate of the sample.

4 Results
(1) Three POI parameters were found to be significant impacts with the housing price, namely, basic education facilitates, stores, and cultural facilities in the OLS model. However, stores were found to be negatively correlated with the housing price. (P-Value=0.011370, 0.000306, 0.001482; t-stat=2.542924, -3.653407, 3.133439, 3.203483).

(2) In the GWR model, the standard deviation can judge the dispersion of the contribution values of each influencing factor. The larger the value, the more obvious of the spatial diversity. In the GWR model of our study, the standard deviation of each factor is very large. It indicates that the influence of various factors on the housing price is very significant. According to the analysis results of the GWR model, and then use the Kriging interpolation method to analyze the influence of various factors on the spatial diversity of the housing price in Hangzhou after the implementation of the price regulation, the result can be more intuitively.

a. The range of regression coefficient of restaurants on the housing price is [0.016, 0.314], indicating that restaurants have a positive impact on housing prices in all regions.

b. The range of regression coefficient of living facilities on the housing price is [-0.164, 0.082], which is basically negative, indicating that the living facilities have a negative impact on the housing price. The area where the negative influence is more significant mainly distributed in the east part of Fuyang District, the positive correlation mainly distributed in the west part of Yuhang District and the east part of Xiaoshan District.

c. The range of regression coefficient of entertainment venues on the housing price is [-0.143, 0.133], The areas where entertainment venues have a positive correlation with the housing prices are mainly distributed in the center of Xiaoshan District.

d. The range of regression coefficient of higher education on the housing price is [-0.145, 0.196]. The areas where higher education has a positive correlation with the housing prices are mainly distributed in the south part of Yuhang District, the southwest of Xihu District, Lin'an city and the east of Fuyang District.

e. The range of regression coefficient of basic educational facilities for the housing price is [-0.059, 0.292]. The areas where educational facilities have a negative impact on the housing price are mainly distributed in the Binjiang District, Shangcheng District, the center of Xihu District and the center of Xiaoshan District. Besides, other regions are all positively related, whereas the area with the most positive correlation is in the northwest of Jianggan District.

f. The range of regression coefficient of cultural facilities on the housing price is [-0.208, 0.232]. The areas where cultural facilities have a positive impact on the housing price are mainly distributed in the east part of Yuhang District, the north part of Xiaoshan District and the northeast of Fuyang District

g. The range of regression coefficient of banks on the housing price is [-0.238, 0.185], which is basically negative, indicating that the banks have a negative impact on the housing price. The area where the negative influence is more significant mainly distributed in the east part of Yuhang District.

h. The range of regression coefficient of stores on the housing price is [-0.241, 0.036], which is basically negative, indicating that the stores have a negative impact on the housing price, while in the south part of Xiaoshan District, the negative impact is the greatest.

i. The range of the regression coefficient of the hospitals on the housing price is [-0.179, 0.153], which is basically negative, indicating that the hospitals have a negative impact on the housing price. While in the Fuyang District, the negative impact is the greatest;
j. The range of regression coefficient of transportations on the housing price is [−0.133, 0.290]. The area with the most significant positive impact on housing price is in the center of the Xihu District.

5 General conclusions

This paper uses OLS, GWR, and Kriging interpolation method to analyze the spatial influential factors of new housing price in Hangzhou under the government price regulation. Using OLS and GWR to reveal the different impacts of various infrastructure factors will affect the spatial diversity of housing prices. In the OLS model, the three variables: basic education facilities, stores, and cultural facilities have a significant impact on the housing price, whereas stores have a significant negative impact. The reason may be that most of the areas where the lottery properties located are already mature living areas, with relatively developed commercial and convenient transportation. Therefore, the neighboring houses are not highly dependent on the stores. The GWR model reflects the spatial variability of the contribution of different factors to the housing price quantitatively, it can describe the spatial relationship between the dependent variable and the independent one with geographical location. From the median and average indicators, banks, stores, and hospitals are negatively correlated with housing prices. Additionally, using Kriging interpolation method, the geographical expression and overall evaluation of the spatial structure of infrastructure can be realized, and the impact of various factors on the spatial diversity of housing prices in various administrative regions that implement the price regulation in Hangzhou can be analyzed more intuitively. This paper provides some important empirical evidence for the price control of the new property from the perspective of the future planning of Hangzhou. When carrying out the construction of the new area and the transformation of the old area, the government needs to fully consider the impact of spatial factors on the development of the real estate market. It is extremely important to analyze the cause of the price of the new property based on local conditions and optimize the spatial structure of housing prices to promote the healthy development of the urban real estate market.