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Research on the Capitalization Effect of Local Public Goods in House Price and Its Spatial Heterogeneity in Zhengzhou

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Abstract: Studies have shown that local public goods has long been significantly capitalized into housing prices in a large number of first-tier cities in China. Residents can directly obtain the public goods by purchasing houses. In addition, more deeper researcher show that there is spatial heterogeneity in the capitalization rate of local public goods. In this paper, based on the transaction data of the new residential houses in Zhengzhou from 2006 to 2015, the Spatial Autoregressive model (SAR) and Geographical Weighted Regression (GWR) are uesed to explore premium effect of the high quality educational resources, subway stations and other local public goods. The empirical results show that, in Zhengzhou, the capitalization effect of "key primary schools" and subway stations on housing prices is significant, and the spatial heterogeneity of its capitalization effect exists. However, the effect of the parks and the top-hospitals is not significant in the real estate market of Zhengzhou.

Keywords: Local Public Goods, Capitalization Effect, Spatial Heterogeneity

1. Introduction

In recent years, with the continuous development of China's economy and the level of urbanization, the real estate market has been developing rapidly during 2005-2015. For example, the housing prices of the first-tier cities have more than tripled, the ones of the second-tier cities have similar improvement last 10 years. At the same time, the increasingly high housing prices gradually become the focus of social concern, but also attract a large number of scholars to explore the housing price mechanism. At present, in the relevant research, what is the most interesting is the capitalization effect of the local public goods on housing price.

Generally, local public goods means that the members of a certain region can share this specific forms of public goods. In this paper, local public goods refer to public facilities which are not competitive in certain area but are not non-excludable, such as rail subway stations, primary schools, hospitals, landscapes and so on. With the gradual development of the real estate market and the free flow of residents in the city, residents have gradually adopted the "vote with their feet" approach. Through the choice of residential areas, they could obtain good education, transportation and other local public goods, and meet all aspects of demand. At the same time, empirical studies have shown that the spatial distribution of high-quality local public goods directly affects the spatial distribution of residential market price in the region. In the case of high quality educational resources, there is obvious shortage of supply and unequal distribution of space within each city. In Zhengzhou, "key primary schools" account for about 20% of all primary schools and the majority of them locate in the Third Ring Road.

Based on the micro-transaction data of Bejing, Long et al. [1] pointed out that with the control of the residential price spatial correlation, the residents would pay 6.2%, 11.9%, 16.8% of the residential price premium for park, bus station and subway station within 800 meters. Huang et al. [2] used the new commercial housing and second-hand housing transaction data of 2010 and 2011, and found that with the freedom of chosing houses, schools, air quality, traffic, and the level of local public goods have a significant impact on neighboring housing prices.

At the same time, in recent years, some domestic and foreign researches in this field have found that there is significant spatial heterogeneity of the local public goods

capitalization effect in the housing price. In other words, the capitalization level of the same local public goods is different in different locations. In general, the spatial difference of local public goods is mainly due to the spatial difference of residents' demand for public goods and the spatial difference of housing supply. Sun et al. [3] studied the impact of supply constraints and demand intensity on spatial heterogeneity with the spatial econometric model and GWR model, based on Chengdu new residential transaction data of 2011.

Indeed, empirical researches have given us a lot of research methods, and we can have a clearer understanding on the mechanism. However, the researches on the spatial heterogeneity of the capitalization effect are still mainly about the spatial correlation. And the study of spatial heterogeneity still needs to be further improved. In addition, the spatial heterogeneity, more researches are limited to the first-tier cities. Then, in the view of the rapid development of the Zhengzhou real estate market in recent years, whether the conclusion of capitalization effect is all applicable is still worthy of in-depth study.

In this context, this paper, based on the characteristic price model, makes an empirical study on the difference of capitalization effect of local public goods in housing price in Zhengzhou. Considering the significant effect of the spatial correlation of residential price on its own price, this paper firstly introduces the spatial correlation into the Hedonic model equation, and then uses the geographically weighted autoregressive model (GWR). The empirical results show that the empirical results are more consistent and improve the model fitting degree, enriching the local public goods capitalization effect on the housing prices, at the same time, Zhengzhou City in the public goods and the spatial distribution of the real estate market Coordinated development.

The second part is about the Zhengzhou real estate market and the distribution of public goods. The third part is the introduction of data and the measurement model hypothesis. The fourth part is the empirical result. The fifth part is the conclusion and the policy suggestion.

2. The Real Estate Market and the Distribution of Public Goods

2.1. The Introduction of Real Estate Market

Since the 1990s, the marketization of real estate market has been accelerated and has become an important pillar of national economic development. At the same time, as the basic condition for the existence and development of other industries, the real estate market has become the focus of attention. Zhengzhou, as an important transport hub in central China, has a unique geographical advantage in the development of real estate.

In 2015, the GDP of Zhengzhou ranks 15th with the 9th largest population in China. So the obvious advantage of the population for the Zhengzhou City real estate market provides a strong buying base. In the past 10 years the overall housing market supply and demand trends, except 2008 and 2011 (This may be related to the year of the purchase policy), is very healthy, but also confirms the commercial housing market is able to resist risks. Based on the demand structure of the last three years, two-bedroom and three-bedroom residential are main products, especially after the "two children" policy liberalization.

2.2. The Distribution of Local Public Goods

In this paper, local public goods are mainly divided into subway station, primary school, green park and the top-hospitals. URRT is a fast, efficient, safe, comfortable, energy-saving and environment-friendly high-capacity urban passenger transportation system. Due to the widespread urban traffic congestion, environmental pollution and shortage of land resources, developing URRT is widely considered to be an effective way to solve these contradictions and problems. As the end of 2015, Zhengzhou Metro has one operating line, with 20 operating stations and 26.2km.

Within the urban area of Zhengzhou City, a total of 117 primary schools. The government will ensure that every school-age child can enroll in the school, so the distribution of primary schools in space is more closely matched to the distribution of the population in the whole city. But specific to the "key primary schools [third-party institutions from primary school grades, school facilities, the rate of 4 comprehensive rankings given after the top ten key primary schools.

In Zhengzhou, there are 32 key schools, which accounts for about 27% of all primary school. From the layout of space," key primary "mostly concentrated in the urban areas. In other words, the quality of education received by the children in suburbs is not as good as the that of the peers in the center. What is the most important is that our history and culture has determined the urgent need for the houses around the key primary schools. And this also leads to big premium.

Urban park or green space, as important natural landscape elements and recreational places in the city, is not only important public goods, but also important symbol to measure the level of urban construction and civilization. It plays an important role in improving urban ecological environment, improving the quality of life of residents and shaping the image of the city. Among the 81 park plots within the Fourth Ring Road, 34 parks are distributed within the second ring, and 14 ones are distributed outside the third ring. From the view of quantity, the number and density of parks is higher in the city center.

3. Data and Empirical

3.1. Data

Zhengzhou has 6 districts, 1 county and 5 county-level cities. The research scope of this paper is the central city of Zhengzhou (within the Fourth Ring Road), including Huiji District, Zhongyuan District, Guancheng District, Jinshui District, Erqi

District and Zhengdong New Area. In this paper, local public goods contains: primary schools, subway stations, parks and the top-hospitals, which are from the Zhengzhou City Department of Education, Zhengzhou Rail Transit official website, Baidu map and Zhengzhou City Health Bureau.

We use the housing project transaction data of 2014 and 2015 from the Zhengzhou Real Estate Trading Center. The houses are built last 10 years, which are the 70-130 square meters of two-bedrooms and three-bedrooms. We have 476 residential district samples. The data includes the building area of the housing project, plot ratio, greening rate, age of house, transaction price and transaction year of the project. The spatial distribution of the project is obtained by Arc GIS (Figure 1).

In addition, combined with previous studies and domestic reality, the local public goods selected in this paper are related to education, subway, medical care, and parks. For metro stations, this paper only considers 20 operating subway stations in 2015. According to the comprehensive consideration, we choose the top 10 schools as the key primary sample. We get parks and greenbelt from parts of the Bureau of Forestry Bureau and other agencies with the Sogou map, Baidu map, a total of 32 samples. The hospital for the provincial health department lists 24 top-hospitals.

The name, meaning and descriptive statistics of the core variables in the empirical model are shown in Table 1.

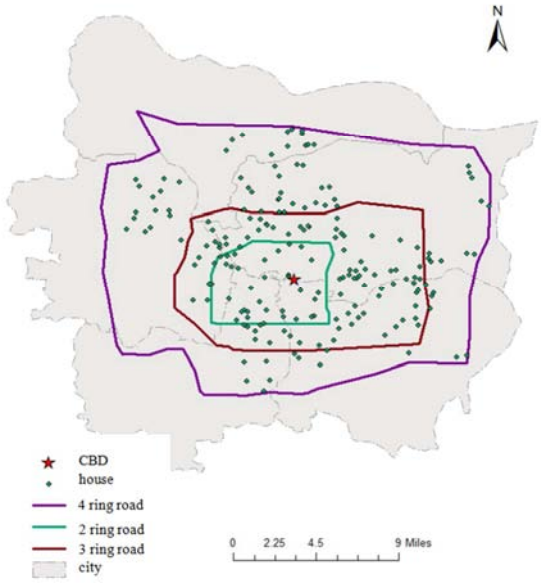

Figure 1. *Spatial distribution of new commercial housing projects in Zhengzhou in 2006-2015.*

Table 1. *The name, meaning and descriptive statistics of the core variables.*

Varible	Description	Sample Size	Average	Standard Deviation
HP	The average price of residential district(yuan/㎡)	476	9030	2066
green_rt	Plot greening rate	476	34.36	5.82
volume_rt	Residential volume ratio	476	3.56	1.3
age_buil	housing age	476	3.49	2.56
D_CBD	Distance to the CBD	476	4.68	2.08
acc_sub	Metro accessibility index (within 600 meters)	476	0.11	0.19
acc_schl	Key primary accessibility index (within 1.2 km)	476	0.09	0.22
dum_pk	Dummy variable, 1 = park within 1.2 km, 0 = other	476	0.52	0.5
dum_hspl	Dummy variable, 1 = top hospital within 1.2 km within, 0 = other	476	0.34	0.47

3.2. The Existence of Premium

In the first step of the empirical analysis, we use the Spatial Autoregressive Model (SAR) to test the existence of premium effects of local public goods. Then the GWR model which can accurately measure the spatial heterogeneity of the model parameters is used to estimate the local public goods premium level of the new commodity housing in the central city area of Zhengzhou, and the spatial heterogeneity is tested statistically.

According to the data situation, first determine the classical feature price model (Hedonic) form:

$$\begin{aligned}\ln(HP) = {} & \beta_1 D\_CBD + \beta_2 Green\_rt + \beta_3 Volume\_rt + \\ & \beta_4 Age\_buil + \beta_5 ACC\_sub + \beta_6 ACC\_schl + \\ & \beta_7 Dum\_pk + \beta_8 Dum\_hspl + Dum\_time + \varepsilon\end{aligned} \tag{1}$$

D_CBD means the distance to the CBD which is a property of the characteristics of housing location. In general, the closer to the center, the prices of the house higher. Green_rt, Volume_rt, Age_buil were plot greening rate, floor area ratio, construction age. Dum_time is a dummy variable used to represent the transaction time, 1 = 2015 transaction record, 0 = 2014 transaction records, used to control the impact of time changes on house prices;

The spatial correlation index Moran's I of the residuals was estimated by Hedonic model and tested. If the index is significant, it indicates that the data is space-dependent and needs to be further analyzed by SAR model to ensure the correct setting of the model. The basic form of SAR model is:

$$\begin{aligned}\ln(HP) = {} & \rho W_1 \ln(HP) + \beta_1 D\_CBD + \beta_2 Green\_rt + \beta_3 Volume\_rt \\ & + \beta_4 Age\_buil + \beta_5 ACC\_sub + \beta_6 ACC\_schl + \\ & \beta_7 Dum\_pk + \beta_8 Dum\_hspl + Dum\_time + \varepsilon \\ \varepsilon = {} & \lambda W_2 \varepsilon + \mu\end{aligned} \tag{2}$$

ρ is the spatial correlation coefficient, in the range of [-1 ~ 1]. If it is positive, between the model of housing price data there is a positive spatial correlation. And W_1 and W_2 are space weight matrices, which are used to characterize the spatial adjacency between the samples. As the estimation of

the model is carried out by GeoDa. GeoDa provides two methods to construct the weight matrix of the sample data space: threshold method and K nearest neighbor method. W form of this article set the threshold method. Construction of spatial weight matrix:

$$W_{ij} = \begin{cases} 1, & d_{ij} <= b \\ 0 & others \end{cases} \quad (3)$$

d_{ij} is the spatial distance between the sample points i and j, and b is the threshold value. It is determined that the cross-validation (CV) method proposed by Cleveland (1979) and Bowman (1984)

$$CV = \sum [y_i - \hat{y}_{\neq i}(b)]^2 \quad (4)$$

$\hat{y}_{\neq i}(b)$ is the fitted value of y_i. When the CV value reaches the minimum, the corresponding b is the required bandwidth.

The spatial autoregressive model is a spatial lag model or a spatial error model, and is tested according to the Lagrange multiplier proposed by Anselin (1988).

3.3. The Measurement of Spatial Heterogeneity of Premium Effect

After the general model is established and the premium effects of local public goods are tested, we begin to discuss the spatial heterogeneity of premium effects. In order to test the spatial heterogeneity, we use the geo-weighted regression model to calculate the capitalization rate. GWR model can flexibly reside in the optimization weight, and for each kind of public goods, each sample point corresponds to a different premium level (ie capitalization rate). GWR model specific form is as follows:

$$\begin{aligned} \ln(HP) = {} & \beta_0(\mu_i, v_i) + \beta_1(\mu_i, v_i)\, D\_CBD + \beta_2(\mu_i, v_i)\, Green\_rt + \\ & \beta_3(\mu_i, v_i)\, Volume\_rt + \beta_4 Age\_buil + \beta_5(\mu_i, v_i)\, ACC\_sub \\ & + \beta_6(\mu_i, v_i)\, ACC\_schl + \beta_7(\mu_i, v_i)\, Dum\_pk + \\ & \beta_8(\mu_i, v_i)\, Dum\_hspl + Dum\_time + \varepsilon \end{aligned} \quad (5)$$

(u_i,v_i) is the coordinate of i, $\beta_i(u_i,v_i)$is the value of the continuous function $\beta_k(u, v)$ at point i (Lu & Zhen, 2010). It is estimated that the GWR model can calculate the coefficient value corresponding to each sampling point i. The coefficients of ACC_sub and ACC_schl are respectively tested for difference. If significant spatial heterogeneity of the local public goods capitalization rate is significant, the premium heterogeneity exists.

The estimated values of the coefficients in the GWR model are:

$$\hat{\beta} = (X^T W X)^{-1} X^T W y \quad (6)$$

The GWR model used in this paper uses the Gaussian function to set the weight matrix. Although we can analyze and estimate the GWR model by using the similar analysis software, such as Stata, Matlab and Arc GIS, but considering the time and efficiency, the econometric tool GWR4 [GWR4 is developed by a number of foreign scholars dedicated to geo-weighted regression model analysis tool.] is the best choice to meet the needs of this article.

4. Empirical Results

4.1. The Existence of Premium Effects

The model regression results of the premium effects of various kinds of local public goods are shown in Table 2.

From the results of the Hedonic model in (1), all the coefficients of the model are in accordance with expectation and are significant. The Moran's I value of the model residuals is 0.0915. The statistic test shows that there is a significant spatial dependency of the model data, and the Lagrangian multiplier test shows that both the spatial error model and the Lagrangian multiplier of the spatial lag model are che, but only the robustness of the spatial error model robustness is significant. Therefore, this paper selects the spatial error model.

From the (2) column, the spatial correlation model has a better explanatory power (R^2 is significantly higher than the OLS), and the estimation accuracy is higher. SAR model residual Moran's I value is 0.003688, and the statistical test is not significant. The spatial dependence of SAR model residuals is not significant. Key primary schools and rail transportation have a significant impact on housing prices. The distance to rail transportation has decreased by 10% recently, and housing prices will rise by 1.3%. The price of "key primary schools" will be 29.9% higher than other houses.

Table 2. *Regression Results.*

Variable	(1) Hedonic	(2) SAR
CONSTANT	9.093***	9.174***
D_CBD	-0.018***	-0.038***
AGE_BUIL	-0.018***	-0.020***
GREEN_RT	0.004*	0.003
VOLUME_RT	-0.014	-0.009
DUM_TM	0.065***	0.072***
ACC_SUB	0.326***	0.278***
ACC_SCHL	0.313***	0.299***
DUM_PK	-0.028	0.004
DUM_HSPL	0.014	0.014
LAMBDA		0.824***
Sample size	476	476
R-square	0.18	0.266
Moran's	17.05	
Lagrange Multiplier(lag)	129.15***	
Robust LM(lag)	0.21	
Lagrange Multiplier(error)	151.87***	
Robust LM(error)	22.93***	

Note: *,**,*** respectively indicates 90%,95%,99% confidence level

Specifically, the coefficient of spatial error correlation coefficient-LAMBDA in the SAR model is 0.824, which indicates that there is a positive correlation between the housing price and its neighboring housing price in

Zhengzhou City, and the housing price is high near the housing price. Low, then the location prices are low. In the control of spatial dependency, the impact of building age on housing prices was significantly negative, the longer the housing age, the higher the unit price. (D_CBD) is negative, indicating that the housing price has a negative gradient with increasing distance to the center of the city. The dummy variable Dum_tm of the reaction time is significantly positive, indicating that the housing price of 2015 is 7.2% higher than 2014.

In the SAR model, the "key primary" and subway station capitalization rate indicators are positive and significant, indicating that the "key primary schools" and the accessibility level of the subway stations have a significant impact on housing prices: when it comes to subway stations, for every additional standard deviation of 0.1, a positive impact of 2.78% on house prices can be achieved, while the increase of 0.1 standard deviation of "key primary schools" will bring about a corresponding increase of 2.99%. However, as the control variables of the top-hospitals and parks on the average residential area of residential green is not significant.

4.2. The Spatial Heterogeneity of Premium Effects

We use the GWR model to analyze the spatial heterogeneity of the premium effects in the two primary public goods, namely, primary schools and subway stations. The estimation results of the GWR model give the coefficient of variation for each sample point. Table 3 gives the statistics of the estimated coefficients. The 25% quantile, median, and 75% quantiles of the coefficients are given in detail, and the significance is tested according to the P value.

In the GWR regression, the optimal bandwidth is calculated as 138, and the AICc value is decreased from -10 to -60 in the OLS global regression. Similarly, the GWR is much better than the OLS regression, and The GWR model is valid.

Table 3. *GWR Local Regression.*

Variable	25%	Median	75%	t
Intercept	9.08***	9.14***	9.25***	86.4
Age_buil	-0.03***	-0.02*	-0.01	-1.6
ACC_sub	-0.24	0.08	0.37***	-0.1
ACC_schl	0.07	0.25*	0.39***	0.9
Dum_pk	-0.07	0	0.06	0
Dum_hspl	0.01	0.07	0.13*	1.0
Sample	476			
R-square	0.39			

Note: * indicates 90% confidence level is significant; ** 95% confidence level is significant; *** indicates 99% confidence level is significant

Combining SAR model and GWR model, we find that the plot ratio and greening rate of residential area are still not significant, which may be due to two reasons: First, more transaction data to buy is the forward house [refers to the construction that has not yet completed the construction and can not be delivered to the use of housing.]. Buyers can not have a more intuitive feeling on the volume rate and green rate; Secondly, in Zhengzhou, house buyers are still not like those from Beijing, Shanghai and other first-tier cities where residents are more rational consideration of various capitalization benefit of local public goods in housing price. According to the heterogeneity of the urban public goods capitalization effect, the coefficient of 75% quantile of the subway is 0.39, and the premium effect is significant. From the subway accessibility index, although the coefficient of the median is reduced, it is still significant. However, the 25% quantile premium effect is not significant. While the median and 25% quantile utility of accessibility is not significant; the park premium effect is still not significant, but the hospital 75% quantile premium effect is significant.

In the real estate market of Zhengzhou, spatial autoregressive model and geo-weighted regression model can better estimate the capitalization effect of local public goods than OLS. And GWR model can better consider the existence of spatial heterogeneity, and estimate the capitalization rate of public goods in each sample point in order to fully reflect the spatial distribution characteristics of public goods capitalization rate.

In addition, the focus of primary schools, subway, housing age and other effects are obvious. But the green rate, volume rate, park, top - hospitals are not significant. Subway stations and key primary schools are with significantly high premium, but premium of green rate and the parks is irrational, which maybe reflect the scarcity of such high-quality public goods and residents of its major needs. The heterogeneity of the capitalization effect of the top - hospitals also shows that the hospital is a kind of local public goods which has both positive and negative effects.

5. Conclusion

Based on this study, this paper proposes the following two suggestions:

First, the provision of more quality public goods to areas with more new housing or high capitalization rates of housing prices. Empirical research shows that in the urban center area and the Zhengdong New Area, house prices are relatively high. In the central urban area, the main reason is that the area has a large number of high-quality public goods (such as key primary schools, rail transit, etc.), but due to limited land supply and mostly built old city, it is difficult to provide more housing area, And a large number of families for their children to obtain higher quality education and the convenience of transportation, making the higher prices, in the face of this situation, we should learn from some first-line quality schools to open campus practice, that can alleviate supply and demand in the region, But also to ensure the quality of school teachers, to ensure equal access to education.

Second, the city government in the city's spatial planning and layout, should take full account of the local public goods and housing market matching, in order to better improve the overall effectiveness of society and promote the harmonious development of society. Based on the research of this paper, we find that the capitalization rate of local public goods in

Zhengzhou is significantly heterogeneous. At the same time, Zhengzhou City in the top three hospitals, park greening on the capitalization effect is not significant and some first-tier cities do not match, which also shows that Zhengzhou as the capital of the provincial capital, still need to improve the quality of education and rail traffic Public goods to meet the local residents and other cities in the province of public demand for such goods, the Government in the development of public goods planning policy should be differentiated between different public goods demand level, go to supply the most urgent needs, so that Better improve the effectiveness of the residents and improve the efficiency of the real estate market and promote the harmonious and orderly development of local society.

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