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Spatial Pattern of the Determinants for the Private Housing Rental Prices in Highly Dense Populated Chinese Cities—Case of Chongqing

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Abstract: The private housing rental market has rapidly developed and demonstrated its outstanding contribution to improving affordability for the floating population in China. However, the forming pattern of private housing rental prices (PHRP) remains poorly understood in China's highly dense populated cities. This study aims to comprehensively investigate the determinants of PHRP and depict their spatial pattern, considering the diverse functions of different areas within the city. A theoretical framework of the factors that influence PHRP has been developed based on an extensive literate study. Taking Chongqing city as a case, a Multiscale Geographically Weighted Regression (MGWR) analysis based on data from Lianjia.com and 58.com was conducted to investigate the spatial pattern of those influencing factors. The PHRP in Chongqing were mainly shaped by the factors of traffic condition and the neighborhood environment. The main findings highlighted that the influence of traffic condition on rental prices is more dominating in the industrial and financial zones, and the neighborhood factors represent spatial heterogeneity in the educational and commercial zones. This study provides a comprehensive examination of the spatial pattern of PHRP's determinants in highly dense populated Chinese cities, extending the understanding of factors influencing housing rental prices. Practically, it provides scientific and reliable recommendations for the local governments and housing agencies in developing housing properties that consider the needs of the floating population. Moreover, tenants in highly dense populated cities benefit from suggestions about looking for proper accommodation with high value and accessibility in different functional zones of the city.

Keywords: private housing rental prices (PHRP); highly dense populated city; Multiscale Geographically Weighted Regression (MGWR); spatial heterogeneity

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1. Introduction

In recent decades, China's housing market has experienced a meteoric rise. Today, the real estate industry has become one of the most critical driving forces of economic development in the Chinese context. In 2021, China's real estate development investment has achieved 14,762 billion CNY, presenting a 4.4% yearly growth [1]. In traditional Chinese culture, owning a housing property is a critical life goal, which is deeply rooted in the heart of most Chinese people. With the anticipation of rising house prices, plenty of investors and speculators have been seeking opportunism and growing housing demand. High-level housing privatization and overheated market investment have raised the price-income ratio far beyond six, forming an unhealthy market with "real estate bubbles" according to international standards [2]. That is to say, high housing prices have not only contributed to the urban property but also led to a severe public problem: there exist plenty of urban residents who cannot afford private housing property [3].

To address the issue, the government at all administrative levels has taken the responsibility for building the largest housing security system in the world and providing a large amount of public rental housing with limited rental prices, thereby resolving the living

problem for citizens, especially the low-income groups [4]. More than 80 million sets of public rental housing have been built up to 2021, meeting the rigid housing demand for more than 200 million. Nevertheless, due to China's unique "hukou" system, registering citizens' residencies in different cities is difficult. In this situation, numerous well-educated, undocumented white-collar workers with decent jobs in high-tech industries and central business districts, referred to as the "floating population", are being excluded from the local housing security system in most Chinese cities [5,6]. Since many of them cannot afford private housing property, seeking residence in the private rental housing market has become their primary option.

The rental price is the indicator of the private housing rental market regarding the aspects of health, affordability, and development trends. The forming mechanism of PHRP reflects the property's value and tenants' preference, which has drawn much attention from researchers [7]. Particularly, in highly dense populated Chinese cities, the influencing factors of PHRP are much more complicated due to the dramatically growing scale of the floating population. However, the PHRP and spatial pattern of their determinants remain poorly understood for these crowded cities. As such, the hidden rules of how the PHRP is being measured remain unclear, leading to irrational choices in looking for temporary accommodation, especially for newcomers in the metropolis [8]. Moreover, private housing agencies in high-dense cities find it particularly difficult to formulate and adjust the PHRP across regions within the mega-cities, while the spatial characteristic of the PHRP and determinants are not well captured by the supply sides [9].

Chongqing, located in southwest China, is a typical high-density city that has long served as a pilot city for rental housing in China. It has the largest urban area (1496.72 km^2) and the fifth-largest urban population (11.86 million at the end of 2018) of any Chinese city [10]. As a new first-tier Chinese city, Chongqing has the largest net population inflow in China [11]. As a result, there is a substantial rigid demand for private rental housing. However, what is the status quo of the PHRP and its determinants remain unclear in Chongqing. Chongqing is a polycentric city, with each district displaying its particular urban attributes. In this sense, revealing the determining mechanism of the PHRP would further depict the urban space and development characteristics in population-dense mega-cities, thus contributing to better develop urban strategies for promoting urban attraction and competitiveness.

Taking Chongqing as the case city, this paper aims to explore the spatial pattern of the PHRP and its determinants in high-density population Chinese cities. The study is dedicated to achieving two sub-objectives: (1) to probe the influential factors of the PHRP and (2) to investigate the spatial heterogeneity of the determinants of PHRP in different urban districts. Accordingly, this paper is structured as follows. Section 2 presents a comprehensive in-depth literature review. The methodology conducted in this research is illustrated in detail in Section 3. Section 4 presents the empirical results, which is followed by Section 5, the discussion part and practical implication. Finally, the critical information is summarized in Section 6, as well as the limitations and prospects.

2. Literature Review

2.1. Private Housing Rental Market in China

Due to the fast-paced urbanization and exorbitant housing prices in China, the housing rental market has become increasingly important for meeting people's living demands, particularly in metropolises with large "floating populations". To meet such demand, many resources have been invested by the Chinese government in establishing the system and providing the supply of public rental housing [12]. However, the above efforts have not yielded the desired results. It is argued that public rental housing is a failure in China since the projects discriminated against the "floating population" and generated conflicts of interest between central and local governments [13]. Furthermore, due to the low profitability and deplorable rental condition, Chinese public rental housing is unappealing to private investors. Aside from financial barriers, the main issues with public rental

housing are household registration and social security payments. To be eligible for public rental housing, tenants must have a residence registration ("hukou") in the city and a certain number of years of social security contributions [13].

The barriers associated with Chinese public rental housing have increased the significance of private housing rental projects [13]. Although public rental housing has greatly benefited the citizens by providing lower rents than private rental housing, the current Chinese public rental housing system only considers the registered low-income public groups while ignoring the needs of the middle-income population and nonlocal citizens due to limited land and financial resources [14,15]. For the time being, these people cannot afford private housing property, and they are unable to participate in the city's public rental housing system due to insufficient social security contributions and "hukou". These significant impediments have contributed to the rising demand for private rental housing in Chinese cities.

Currently, research on the private housing rental market in China is primarily focused on informal markets, such as the renting basement living and urban villages [16–18]. The rise in demand for basement living in Beijing was mainly due to the unaffordability of private housing property and the inconvenient location of most public rental housing [17]. The low cost of renting in urban villages attracts many low-income residents [18]. Aside from the low PHRP, the restrictions of "hukou" also contribute to the aforementioned informal market. In general, current research mainly focused on the informal market and only considered low-income tenants, while the private housing rental market as a whole also includes many middle-income tenants whose preferences have not drawn enough attention.

2.2. Factors That Influence the PHRP

The affordability of middle-income tenants to the private housing rental market largely depends on the PHRP, which is affected by macro-level and micro-level impact factors. Population [19], household [20], urban economic development [20], and the livability of a community [21] are all impacting elements at the macro-level. However, there is also a lag impact of the macro-level influencing factors. Such impact cannot be exerted directly on PHRP in the short term. Under this context, the micro-level influential factors play a more significant role [22].

Three widely accepted theories—the Hedonic Price Theory; Bid Rent Theory and Henry George Theorem—are used to explain PHRP at the micro-level. (1) Hedonic Price Theory, which was extensively employed in the study of housing prices and PHRP, identified the inherent characteristics of housing [23,24]. The Hedonic Price Theory proposed that a commodity was made up of several attributes. In terms of residential buildings, the characteristics were the architectural structure, including area, floor, orientation, etc. The commodity's price was the comprehensive reflection and expression of all these characteristics. A commodity's prices will fluctuate in line with any changes to its properties. (2) The Bid Rent Theory served as the fundamental framework for analyzing location selection and its evolutionary logic [25]. The highest rent is that which a land user—resident or business—is willing to pay to compete for a plot of urban land (a specific location). A tenant could choose to pay a higher rent amount to be near limited educational and medical resources [26]. (3) The Henry George Theorem was one of the major theoretical explanations for disparities between neighborhoods. The term "neighborhood" was a spatial concept that referred to the spatial scope of the adjacent land. Schools, hospitals as well as parks were classified as quasi-public goods by Henry George Theorem, and because such goods form a local spatial pattern under the aggregation of cities, they were also known as local public goods. Residential land costs were relatively high in the area of strong public goods agglomeration.

Grounded on the aforementioned theories, this study concludes three categories of micro-level influential factors on PHRP, including architecture structure, traffic condition, and neighborhood environment. (1) Architectural structure refers to the inherent attribution

of the residential building. Specifically, the attribute includes the floor area of the residential unit [22], the number of bedrooms [27], the orientation of the living room or master bedroom [28], the floor level [29], and the parking space [30]. Together, these aspects jointly influence the prices of private rental housing to a certain extent. In Chinese culture, the south orientation of the living room or master bedroom is much more attractive to the tenants [28], because a south-orientated room can receive more sunlight throughout the day [31]. (2) Traffic condition refers to the transportation convenience and accessibility of the site. The traffic condition is one of the dominant determinants when selecting whether to buy or rent housing. The PHRP is significantly influenced by the distance between the residential building and the nearest public transportation hub [19]. Especially in high-density cities, living close to a metro station and bus stop are of great priority for working citizens since it helps to considerably cut down on their commuting time [5,32]. (3) The accessibility of the closest services and amenities, such as school, restaurant, and hospital, is defined as the neighborhood environment. The connection between the local environment and PHRP has been the subject of numerous research projects. Residents preferred living in a place that is close to primary and middle schools, universities [33], restaurants [34], shopping centers [35], parks [36], hospitals [37], banks [38] and CBDs [39]. Following a review of the literature on micro-level PHRP, a theoretical framework with three categories and 14 factors was constructed, as shown in Table 1.

Table 1. Factors that influence rental housing prices.

Category	Factors	Definition	References
Architectural structure	Area	The construction floor area of the residential unit	[22]
	Bedroom	Number of bedrooms in a residential unit	[27]
	Orientation	The orientation of the living room or master bedroom	[28]
	Floor Level	The level of the floor	[29]
	Parking	Whether the place has parking spots or not	[30]
Traffic condition	Subway	Distance to the nearest metro station	[5]
	Bus	Distance to the nearest bus stop	[32]
Neighborhood environment	School	Distance to the nearest school	[33]
	Hospital	Distance to the nearest hospital	[37]
	Bank	Distance to the nearest bank	[38]
	Restaurant	Distance to the nearest restaurant	[34]
	Shopping center	Distance to the nearest shopping center	[35]
	Park	Distance to the nearest park	[36]
	CBD	Distance to the nearest central business district	[39]

2.3. Methods for Investigating the Determinants of the Rental Housing Prices

Many academics have dedicated themselves to conducting in-depth research on how PHRP is formed by the influencing factors. There are mainly four methods: (1) Hedonic Price Method (HPM); (2) Geographical Weighted Regression (GWR); (3) Semiparametric Geographical Weighted Regression (SGWR); and (4) Multiscale Geographically Weighted Regression (MGWR). The advantages and disadvantages of these methods are summarized in Table 2.

Table 2. Methods for identifying factors that influence private housing rental prices.

Method	Advantage	Disadvantage
HPM	Calculate a large number of data to obtain an intuitive economic sense	Ignore the spatial heterogeneity
GWR	Deal with spatial heterogeneity	Cannot solve the scale difference of spatial heterogeneity
SGWR	Solve the scale difference of spatial heterogeneity	Cannot distinguish which variables are local and global
MGWR	Subdivision of global and local variables	Not revealed yet

The method of HPM is most frequently applied in studying housing prices and PHRP, depicting the functional relationship between various attributes and PHRP [24]. However, HPM does not provide insight into spatial heterogeneity, and the result can only reflect the status quo of the entire region [40]. It is argued that the result of HPM may lead to an unstable result because it cannot solve spatial heterogeneity to some extent [41,42]. Given the importance of spatial heterogeneity in residential buildings, GWR is used to probe the influential factors of PHRP [43]. GWR considered the spatial non-stationarity between variables, which improved the resolution of heterogeneity issues. However, GWR does not consider the scale difference of spatial heterogeneity [44]. To some extent, SGWR can solve the global and local scale problems, but it has an accuracy problem because the scale cannot be further classified. To deal with the above disadvantages, Fotheringham et al. (2017) developed the MGWR method, which remedies the limitations of SGWR [45,46]. The residential unit can be viewed as a special commodity with spatial heterogeneity at various scales. Based on the above, the MGWR model is the most accurate method for PHRP studies by providing the analysis of spatial patterns considering the regional difference.

3. Methodology

A methodology with four steps was designed in this study to identify the determinants of PHRP and their attributes on the aspect of spatial heterogeneity. Figure 1 depicts an overview of the entire methodology design. Firstly, a comprehensive literature review was used to develop a theoretical framework of influential factors based on three theories (Hedonic Price Theory, Bid Rent Theory, and Henry George Theorem). The second step was to collect data on PHRP and the influential factors, crawling from "Lianjia" and "58.com" using Python 3.8.0. The raw data were then processed in the third step through data cleaning (linear regression), data selection (stratified sampling), and data transfer (API conversion). In the last step, MGWR analysis was performed to identify the determinants of PHRP and their spatial heterogeneity.

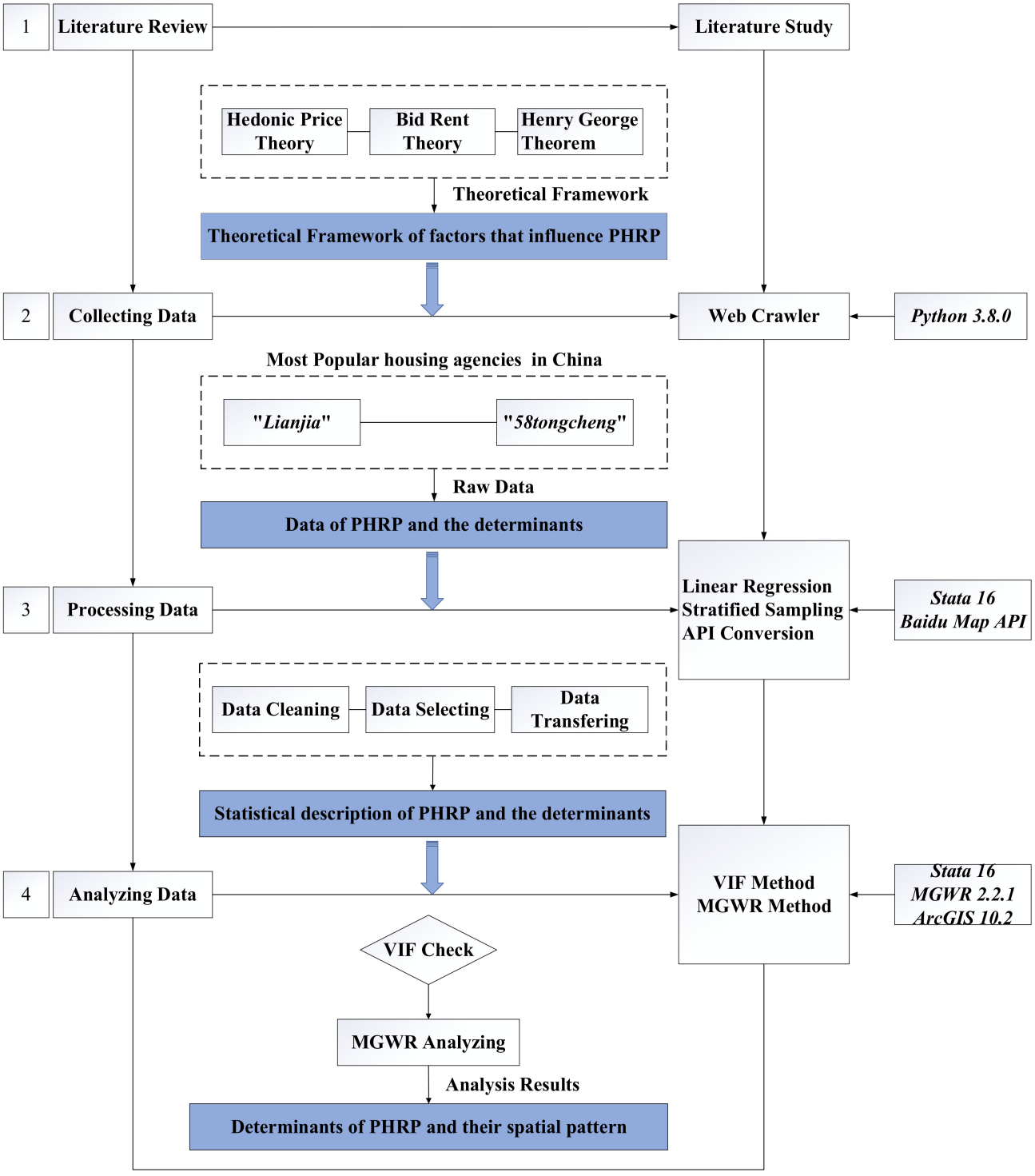

Figure 1. Methodology design.

3.1. Study Area

Being well-known as a high-density mountain city in China, Chongqing has a unique natural topography. The complex terrain variety and limited construction land formed a high-density mountain city landscape [47]. As the industrial and economic center of southwest cities in China, Chongqing has made remarkable achievements in the private housing rental market. The number of rental housing units has reached 73,000 by 2021, accounting for 23% of the total number of housing in the whole city [1]. Along with rapid urbanization, a prominent population agglomeration effect has been revealed. Prosperous urbanization

has created increasing employment opportunities and attracted a new population. The number of floating inhabitants in central urban districts reached 10.3 million in 2020, which makes it one of the largest floating population gatherings in Chinese cities [11]. College students and migrant workers are the main floating population, and they are the target groups of private housing rental tenants.

In this study, eight central urban districts in Chongqing were selected as the study area for data collecting, considering the density of tenants and the data availability [1]. Figure 2 illustrates the location of the study area from three perspectives: the location of Chongqing; the location of the central urban districts in Chongqing, and the location of the four functional zones in central urban districts. As shown in Figure 2, the Jiangbei district is a commercial zone, with an average daily flow of 400,000 people in the Guanyinqiao. The Shapingba district is naturally the educational zone, which is the concentration of many schools and educational institutions. The Yuzhong district is a financial zone, with finance as its first pillar industry. The Yubei district is a typical industrial zone, with secondary industries such as automobile manufacturing and electronic equipment manufacturing flourishing.

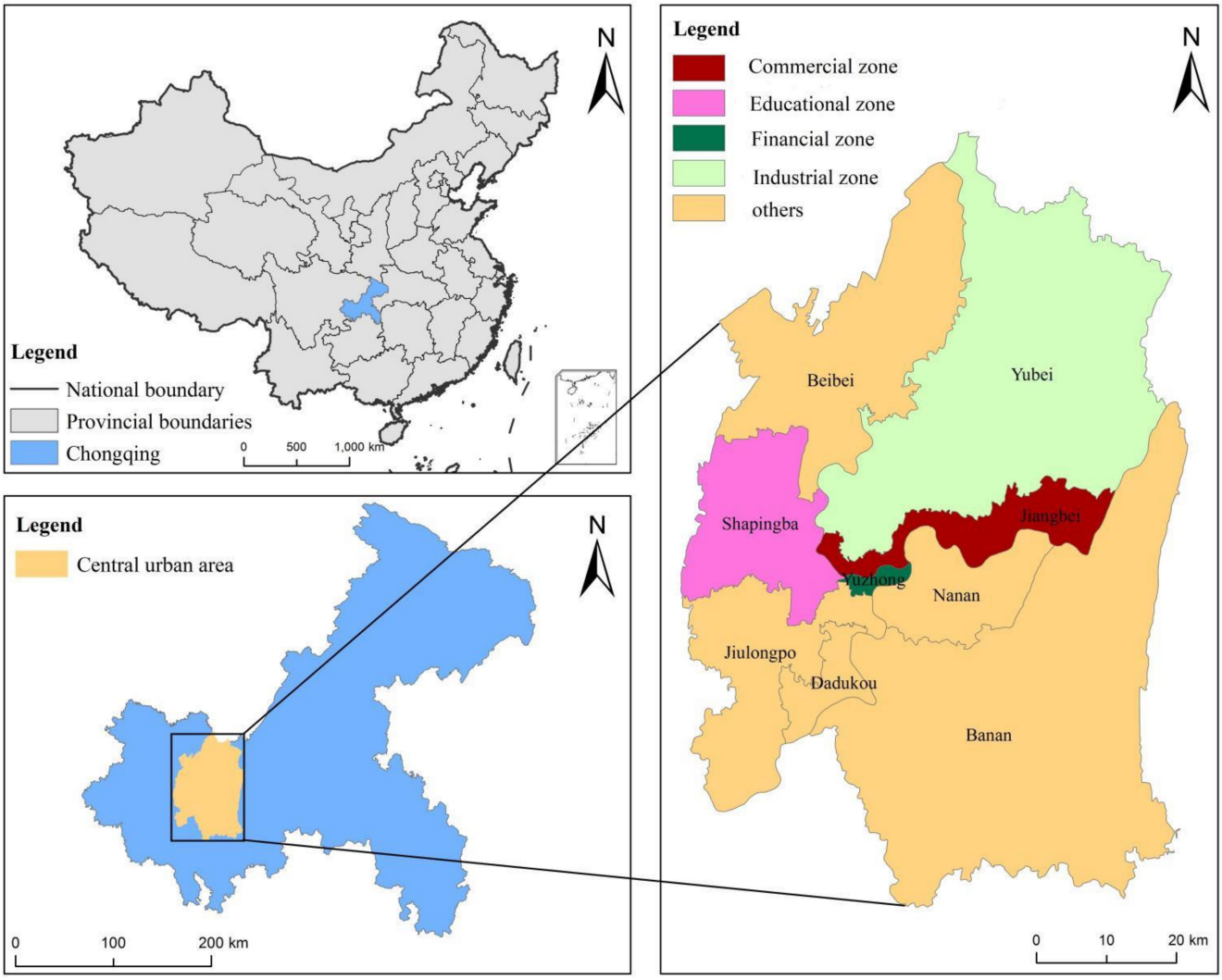

Figure 2. The map of the study area and four urban functional zones in Chongqing.

3.2. The MGWR Model of PHRP

MGWR defines bandwidths of different factors differently, which can reflect variations in the action scales of different variables [45]. Assume that there were n housings, for these housings $i \in \{1, 2, \ldots, n\}$ at location (u_i, v_i). The linear regression model was described by Equation (1):

$$y_i = \sum_{j=0}^{m} \beta_{bwj}(u_i, v_i)x_{ij} + \varepsilon_i \quad (1)$$

where $j \in \{1, 2, \ldots, n\}$ represented the factors that influenced PHRP; x_{ij} was the *jth* influencing factor of the housing I, bwj in β_{bwj} represented the bandwidth used for calibration of the *jth* conditional relationship, $\beta_{bwj}(u_i, v_i)$ was the *jth* factor that influenced PHRP coefficient, ε_i was the error term, and y_i was PHRP.

To calibrate the MGWR model, a back-fitting algorithm was used. The MGWR model can express as generalized additive models (GAMs). According to the logic of GAMs, $\beta_{bwj}x_i$ in MGWR can be represented as the *jth* additive term f_j. The GAMs model was given by Equation (2):

$$y = \sum_{j=0}^{m} f_j + \varepsilon \quad (2)$$

All the additive term f_j should be initialized, and an initial set of estimates y was obtained; subsequently, residuals were calculated. These residuals plus f_0 then regressed on x_0, and an optimal bandwidth bw_0 was obtained. f_0 was updated using a set of estimates of the relationship between y and x_0. The process moved on using the updated f_0 plus f_1 and regressed on x_1 to obtain bw_1. The method was continuous until the last x_m was estimated. The interactions continued until the convergence was reached. The proportional change in the residual sum of squares (RSS) is deemed as a termination criterion. The classical residual sum of squares (RSS) variation ratio was used as the convergence criterion, which was described by Equation (3):

$$SOC_{RSS} = \frac{|RSS_{new} - RSS_{old}|}{RSS_{new}} \quad (3)$$

where SOC_{RSS} represented the proportional change in the residual sum of squares (RSS), RSS_{new} was the residual sum of squares in the present step, and RSS_{old} was the residual sum of squares in the previous step.

3.3. Data Collecting and Processing

Python 3.8.0 was adopted to crawl the data of the factors that influence the PHRP in Chongqing in January 2021. Data from eight central urban districts of Chongqing were collected from two popular rental platforms—Lianjia.com and 58.com [1] (accessed on 15 January 2021). A total of 36,520 raw data from 1935 communities was obtained. Table 3 displays the information (category, unit, and type) of the crawled data for 15 factors that influence PHRP. Continuous variables were valued by their real value; dummy variables were categorized as qualified according to the literature and reality. There are three dummy variables including "Orientation", "Floor level" and "Parking". Specifically, the factor "Orientation" was numbered as "1" (facing south) and "0" (other orientations); Codes "0, 1, 2, 3" were used for qualifying the "Floor level" from low, multi, and middle to high level. The factor of "Parking" was valued as "1" (with parking space) and "0" (without parking space).

Table 3. The information on the factors that influence private housing rental prices.

Category	Variables	Units	Variable Types
Dependent variable	Rent	yuan/month·m^2	C
Architectural structure	Area	m^2	C
	Bedroom	/	C
	Orientation	/	D
	Floor Level	/	D
	Parking	/	D
Traffic condition	Subway	Km	C
	Bus	Km	C
Neighborhood environment	School	Km	C
	Hospital	Km	C
	Bank	Km	C
	Restaurant	Km	C
	Shopping Center	Km	C
	Park	Km	C
	CBD	Km	C

Note: "C" is regarded as continuous variables and "D" is regarded as dummy variables.

The raw data were then processed through three steps: data cleaning, selecting, and transferring. First, a general linear regression was performed to eliminate the outliners by using Stata 16 software. As a result, 29,025 samples were retained as cleaned data. Second, the method of stratified sampling was adopted to further select samples, through which samples from 1935 private housing rental communities were finally prepared. Third, the Baidu Map Application Programming Interface (API) was used for transferring the geocodes (from the open data of Baidu) of the stratified sampling communities to the information on their latitudes and longitudes.

The reliability of the processed data was tested before the operation of MGWR analysis. Table 4 shows the average PHRP of the eight intra-urban districts in Chongqing from 15–45 yuan/month·m^2. The range of the data included consists of the results published by China Real Estate Information (CREI)—China's leading real estate professional database, which contains the PHRP in the majority of cities, indicating the sufficient representativeness of the sample data to the actual situation [1].

Table 4. Statistics of private housing rental prices in eight central districts of Chongqing.

Districts	Available Communities	Minimum Rent (Yuan/m^2/Month)	Maximum Rent (Yuan/m^2/Month)	Average Rent (Yuan/m^2/Month)
Yuzhong	237	21.26	55	29.32
Jiangbei	364	20.93	44.62	27.97
Yubei	228	18.64	40.95	26.82
Nanan	205	16.67	37.57	24.74
Shapingba	198	17.36	31.86	23.13
Jiulongpo	240	18.18	28.57	22.82
Dadukou	211	17.54	24.73	22.20
Banan	252	15.91	22.05	17.43
Total	1935	15.91	44.62	24.30

3.4. Statistical Description

(1) Characteristics of the PHRP in Chongqing

Generally, the average monthly PHRP was relatively equal among the eight central urban districts of Chongqing, but the highest and lowest PHRP in each district differed significantly (Table 4). The average monthly unit private housing rental price was 24.30 CNY/month·m^2 in Chongqing's eight central urban districts. Among them, the

maximum value of the average monthly rent was 44.62 CNY/month·m^2, and the minimum value was 15.91 CNY/month·m^2.

Geographically speaking, PHRP in eight central urban districts of Chongqing decreased from north to south. Private housing with monthly unit PHRP higher than average rent in Chongqing is concentrated in Yuzhong, Yubei, Jiangbei, and Nanan, all of which are in northern Chongqing. This phenomenon appears consistent with the regional development of Chongqing since the high-tech industries, job opportunities, and production services are primarily concentrated in the north of Chongqing. In this sense, it is not surprising that PHRP in the Shapingba, Jiulongpo, Dadukou, and Banan districts in the south of Chongqing are lower than the average PHRP.

(2) Statistical description of the factors that influence the PHRP of Chongqing

Table 5 displays the attributes of the influential factors for PHRP in Chongqing based on the crawled raw data. In terms of architectural structure, the construction floor area of the residential unit ranges from 16 to 158 m^2, while the provided floor area is primarily concentrated between 52 and 160 m^2. The number of bedrooms ranges from one to five; among them, private rental housing with two to three bedrooms accounts for 72% of the total, while rental housings with five bedrooms are rare. The orientation of the living room and master bedroom facing south is nearly identical to that of the non-south. The floor level ranges from low, multi, and middle to high level and assigns values 1 to 4. The maximum distance of traffic conditions and neighborhood environment from the rental housing is 3.7 km, which may reflect tenants' maximum acceptance of the radius of access to these resources.

Table 5. Descriptive statistics of the factors.

	Variable	Mean	Min.	Max.
Architectural Structure	Bedroom	2.30	1	5
	Area	81.582	52	160
	Orientation	0.484	0	1
	Floor Level	2.115	1	4
	Parking	0.749	0	1
Traffic Condition	Subway	2.657	0.100	3.683
	Bus	1.167	0.300	2.572
Neighborhood Environment	School	2.462	0.110	3.330
	Hospital	2.592	0.700	3.732
	Bank	1.694	0.800	2.504
	Restaurant	2.957	0.100	3.172
	Shopping center	1.591	0.300	2.381
	Park	2.369	0.800	3.688
	CBD	1.592	0.300	2.362

4. Results of the MGWR Analysis

4.1. An MGWR Model for Analyzing the Determinants of PHRP in Chongqing

A multicollinearity test for the identified factors was conducted before establishing the MGWR model. Only the factors with non-multicollinearity (VIF < 10) were retained as the input variables for MGWR analysis [48]. The hypothesis of multicollinearity is not rejected for only two factors (Park and CBD), as their variance inflation factors (VIF) exceed the critical value of 10.

Engaging 12 non-collinear factors, the MGWR model first identified the influential factors of PHRP through regression analysis. Table 6 summarized the regression analysis results, revealing that eight factors—Area, Parking, Bus, Subway, School, Hospital, Restaurant, and Shopping—were identified as influential factors that significantly stimulus PHRP in Chongqing, while Bedroom, Orientation, Floor level, and Bank were identified as the non-influential factors. The criteria in MWGR for identifying the significant variables is

that all the p values of the independent variable meet the benchmark ($p < 0.05$). In this study, eight of the twelve factors indicate 100% of $p < 0.05$. There were 1936 p values for each factor.

Table 6. The regression analysis results of the MGWR analysis.

Category	Variable	Significant $p < 0.05$ (%)	Non-Significant $p > 0.05$ (%)
Architectural structure	Bedroom		15.71
	Floor Area	100.00	
	Direction		8.62
	Floor		12.49
	Parking	100.00	
Traffic condition	Bus	100.00	
	Subway	100.00	
Neighborhood environment	School	100.00	
	Hospital	100.00	
	Bank		19.30
	Restaurant	100.00	
	Shopping	100.00	

The MGWR model investigated in depth how these eight influential factors determine the PHRP. Table 7 depicts the coefficient description of the MGWR model, indicating the determinants effects of the influential factors on two aspects: direction and degree. The plus–minus sign of the Mean indicates whether the influential factors have a positive or negative impact on PHRP. Among the eight influential factors, only *Area* had a positive effect on PHRP. The net value of the Mean represents the influential degree of the factor on PHRP. The distance to the subway imposed the strongest impact on PHRP, increasing them by 0.074 yuan/m^2 per kilometer closer. Next to it, the distance to the nearest bus stop and school has the same effect on PHRP, rising by 0.037 yuan/m^2 when the distance is shortened by 1 km. Notably, a mean value of 0.009 indicated the weakest influential effect of the *area* on PHRP in Chongqing.

Table 7. The coefficient description of the MGWR model.

Category	Influential Factors	Mean	STD	Min.	Med.	Max.
Architectural structure	Area	0.009 *	0.271	0.002	0.009	0.017
	Parking	−0.017 *	0.053	−0.024	−0.018	−0.008
Traffic condition	Bus	−0.037 *	0.002	−0.074	−0.037	−0.017
	Subway	−0.074 *	0.002	−0.108	−0.074	−0.059
Neighborhood environment	School	−0.037 *	0.012	−0.061	−0.038	−0.048
	Hospital	−0.034	0.062	−0.038	−0.032	−0.010
	Restaurant	−0.028 *	0.086	−0.039	−0.028	−0.015
	Shopping	−0.052 *	0.000	−0.053	−0.052	−0.052

Note: "*" indicates an effect of the influential factor on private housing rental prices.

4.2. Analyzing the Spatial Heterogeneity of the Influential Factors of the PHRP

The spatial heterogeneity effects of the influential factors were further investigated using the MGWR analysis to analyze better and compare the spatial pattern of the influential factors. The spatial inhomogeneity and complexity of variables are referred to as spatial heterogeneity. Local and global influential factors are used to identify whether there is spatial heterogeneity in these factors. The calibration of local and global factors provides an optimized bandwidth that describes the spatial scale over which the processes being modeled vary [45]. The percentage of the bandwidth was applied as a rule in this study to categorize the influential factors into global and local groups for the spatial heterogeneity analysis. When the percentage of the bandwidth of the influential factors is less than 20%,

that indicates the factors as local influential factors. As shown in Table 8, five factors—Parking, Bus, Subway, School, and Shopping—were classified as the local influential factors considering their sample size at the level of less than 20% of the total.

Table 8. Optimal bandwidth for each influencing factor obtained from MGWR.

Category	Influential Factors	MGWR Bandwidth	Bandwidth as a Percentage of the Total Sample Size
Architectural structure	Area	1927	99.6%
	Parking	168	8.7% *
Traffic condition	Bus	265	13.7% *
	Subway	253	13.1% *
Neighborhood environment	School	185	9.6% *
	Hospital	1572	81.2%
	Restaurant	1798	92.9%
	Shopping	365	18.9% *

Note: "*" indicates the local influential factors of private housing rental prices.

Figure 3 illustrates the spatial heterogeneity of five local influential factors according to the spatial distribution of the coefficients: Parking, Bus, Subway, School, and Shopping. As shown in Figure 3b,c, the distribution of traffic condition (Bus and Subway) was highly uneven. Subway had the greatest influence on PHRP in the Yubei district (industrial zone), which was followed by the Yuzhong district (financial zone). The School coefficient had been found more important to tenants living in the Shapingba district, where educational resources were abundant.

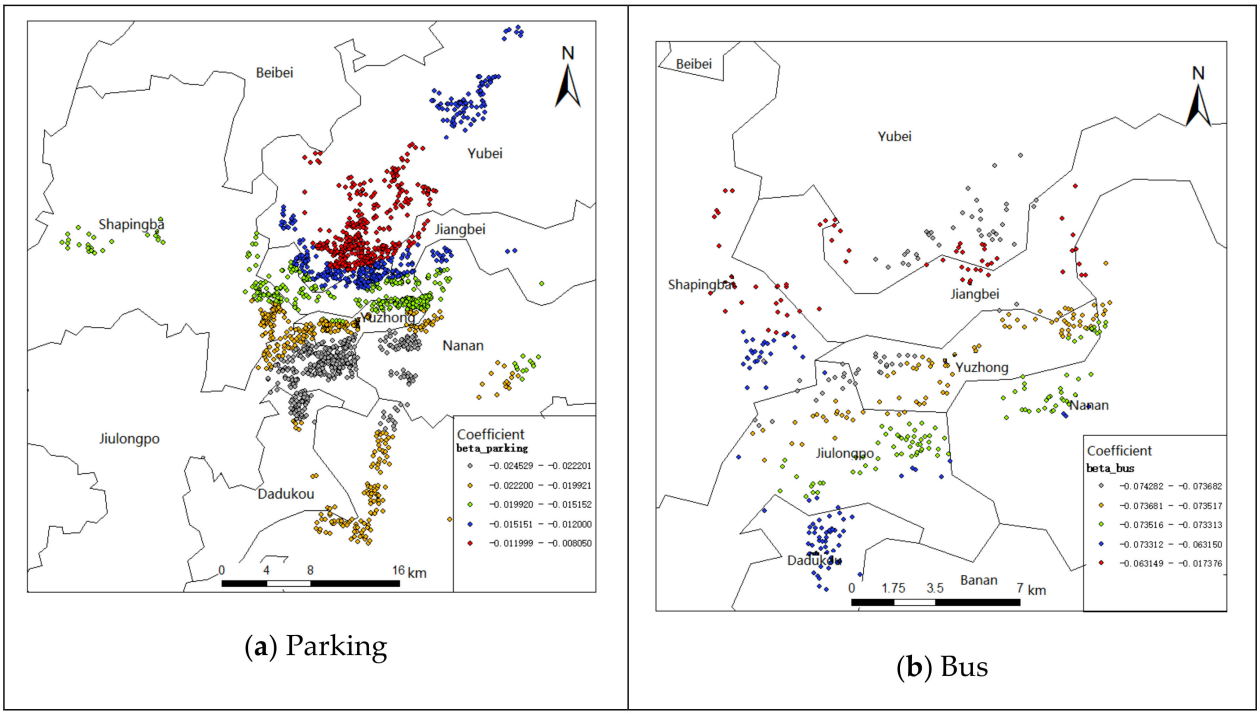

Figure 3. *Cont.*

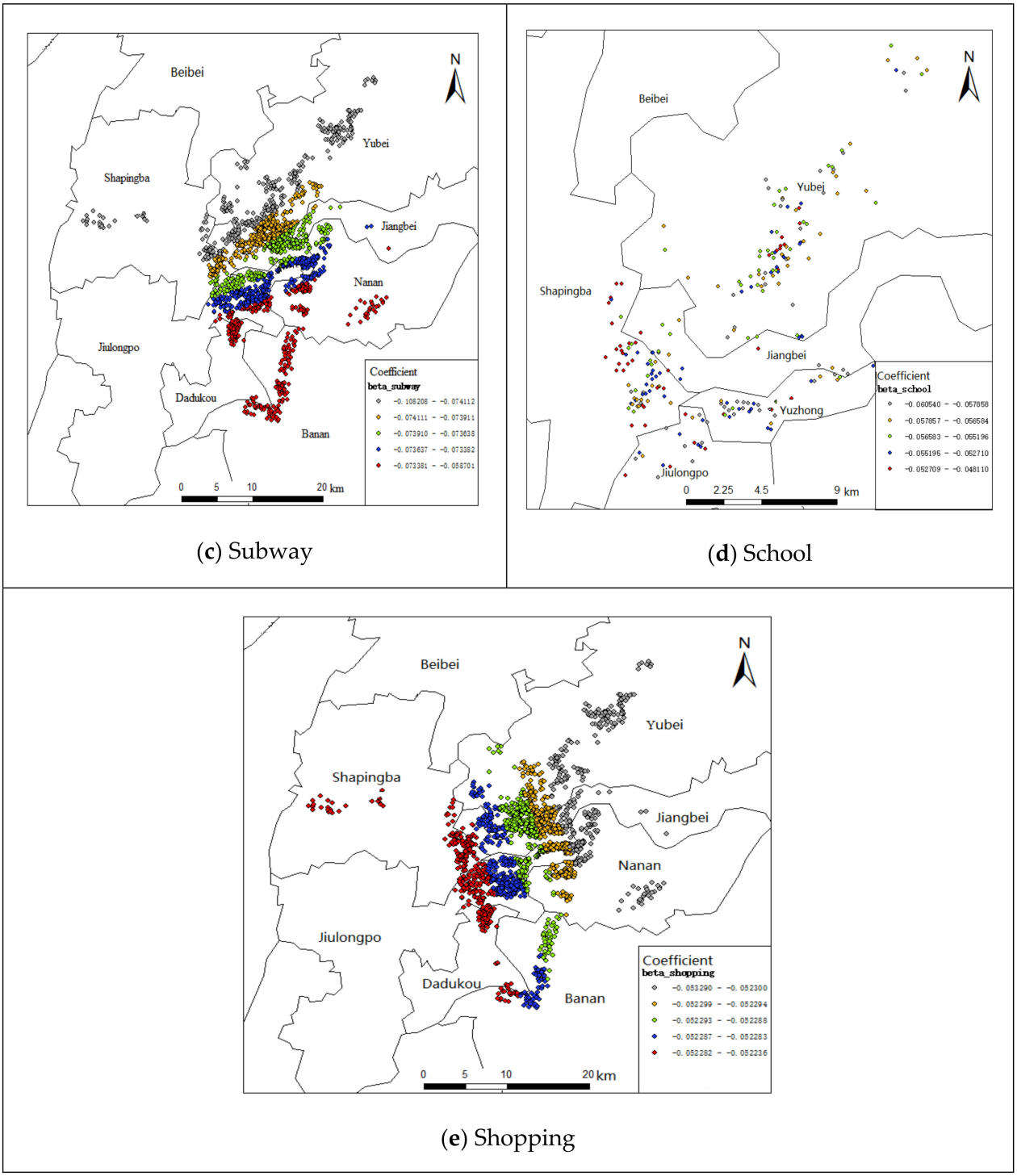

Figure 3. Spatial distribution of the local influential factors for the private housing rental prices in eight central urban districts of Chongqing.

Three globally influential factors are also represented in Figure 4. As shown in Figure 4a–c, the Area, Hospital, and Restaurant coefficients represent spatial homogeneity. The three influential factors have the same degree of impact on PHRP in the eight central urban districts of Chongqing, indicating no spatial heterogeneity.

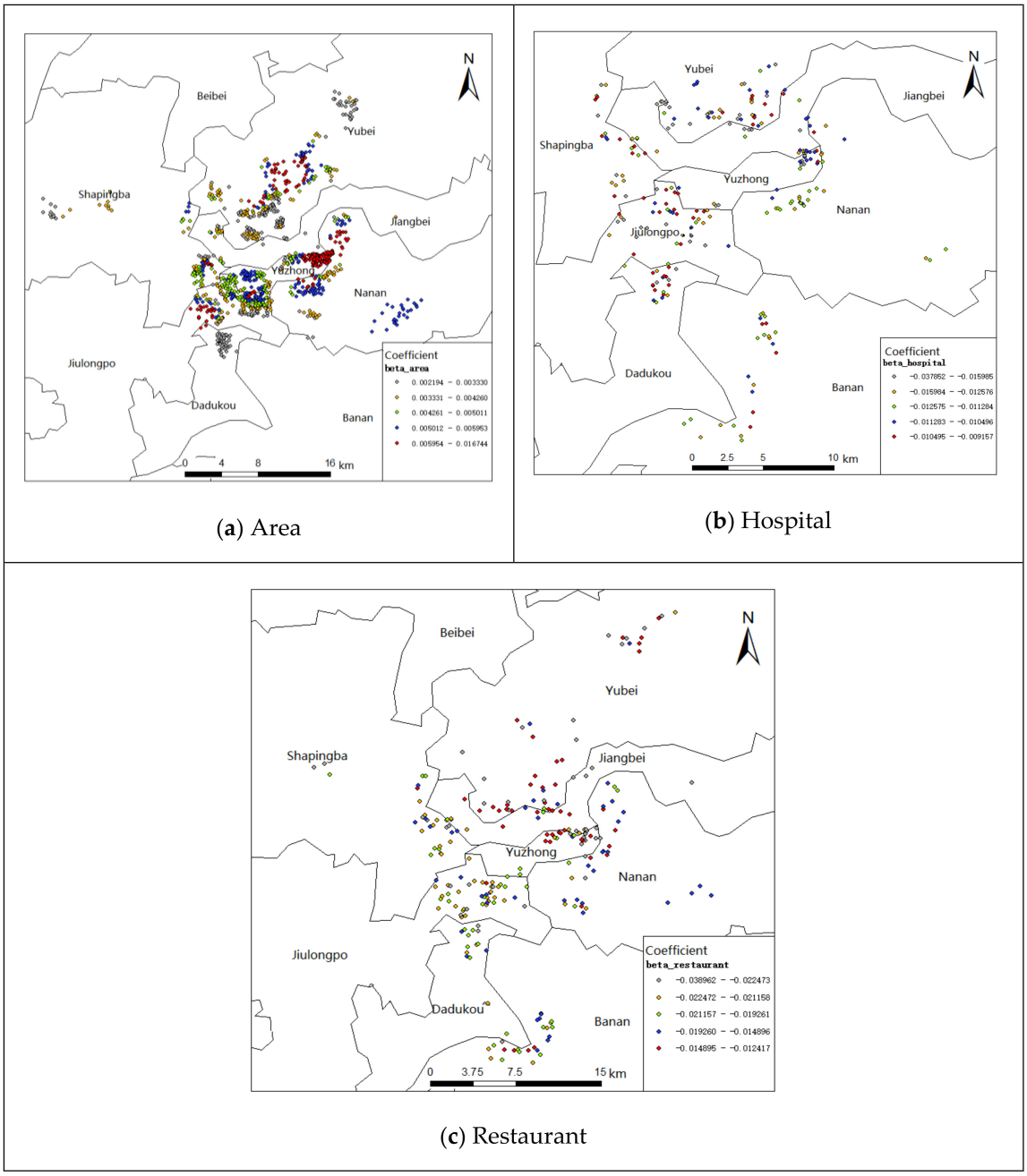

Figure 4. Spatial distribution of the global influential factors for the private housing rental prices in eight central urban districts of Chongqing.

4.3. Robustness Test

To ensure the accuracy and reliability of the MGWR analysis results, another analysis for the determinants of PHRP was performed by the GWR model as a robustness test. A comparison of the results of GWR and MGWR was conducted. First, the OLS analysis is performed to filter variables for further analysis. The results showed that the VIF values of the 12/14 factors were less than 10, indicating that these 12 variables had no multicollinearities. Then, the GWR analysis was followed for the 12 factors. Table 9 describes the significance of eight variables in influencing the PHRP, which is completely consistent with the results of MGWR (Table 6 in the paper). Third, the GWR analysis also showed the coefficients of each variable to the PHRP (see Table 10). In comparing with the results of MGWR, the influence of these critical factors on the PHRP was in the same direction in the GWR analysis (Mean value), although the absolute values of the

coefficients were a bit different. In general, the comparison of the results by GWR and MGWR confirmed the accuracy of identifying the critical determinants and their impacts on PHRP.

Table 9. The regression analysis results of the GWR.

Category	Variable	Significant $p < 0.05$ (%)	Non-Significant $p < 0.05$ (%)
Architectural structure	Bedroom		88.40
	Area	100.00	
	Direction		94.3
	Floor Level		91.6
	Parking	100.00	
Traffic condition	Bus	100.00	
	Subway	100.00	
Neighborhood environment	School	100.00	
	Hospital	100.00	
	Bank		99.9
	Restaurant	100.00	
	Shopping	100.00	

Table 10. The coefficient description of the GWR model.

Category	Influential Factors	Mean	STD	Min.	Med.	Max.
Architectural structure	Area	0.004	0.142	0.002	0.004	0.006
	Parking	−0.016	0.081	−0.032	−0.019	−0.016
Traffic condition	Bus	−0.040	0.064	−0.056	−0.041	−0.038
	Subway	−0.088	0.073	−0.125	−0.085	−0.079
Neighborhood environment	School	−0.043	0.065	−0.058	−0.046	−0.031
	Hospital	−0.037	0.072	−0.061	−0.039	−0.026
	Restaurant	−0.020	0.065	−0.037	−0.020	−0.019
	Shopping	−0.079	0.033	−0.146	−0.078	−0.067

As for the accuracy of the models themselves, the model indexes are given in Table 11. The R2 of MGWR is 0.708 higher than that of GWR, reflecting the higher goodness of fit for MGWR. Additionally, the MGWR model describes the fact of data better than the GWR model with smaller values on the Akaike information criterion (AICc), the number of effective parameters (ENP_j), and residual sum of squares (SSE)., indicating the superiority of MGWR.

Table 11. Comparison of the model indexes of MGWR model and GWR.

Model Index	MGWR	GWR
R^2	0.708	0.635
AICc	4838.829	5128.535
ENP_j	179.785	213.375
SSE	1145.749	1581.171

Given the robustness test above, the results of MGWR analysis are considered as of high validity in this paper.

5. Interpretation and Discussion

5.1. The Determinants of PHRP in Chongqing

Generally, the PHRP is determined by *architectural structure*, *traffic condition*, and neighborhood *environment*. In Chongqing, the PHRP revealed a strong sensitivity to the

Traffic Condition factors in terms of distance to the subway and bus station, while Shopping and Hospital—indicators of the *Neighborhood Environment*—also imposed a significant impact on PHRP.

(1) Transportation facilities add significant value to private housing properties in densely populated cities. This study indicated the strong influence of the distance to the subway and bus stations on PHRP, supporting a common argument that transportation facilities add value to the housing properties in the case of a high-density city. Given the fact that Chongqing is a city with high-pressure traffic, citizens prefer to take public transportation rather than drive. Public transportation's superiority in the aspects of time and cost saving makes the distance to the subway and bus station the most potent determinant in driving the rising of PHRP.

(2) The convenient neighborhood environment increases the PHRP in supplying scarce social resources. The proximity to the shopping center raises the PHRP of private housing in Chongqing, which is a finding that consists of previous research [33,34,37]. The fundamental reason for this is that the comprehensive function of the shopping center conveniences the life of the residents around by meeting their basic daily needs and enriching leisure time. People prefer to live in places where they can meet basic daily needs, and areas near shopping centers are ideal for meeting daily demands, so tenants prefer to pay higher rent. Currently, most shopping centers in Chongqing encompass the services of shopping, catering, and amusement, attracting a large group of young and dynamic citizens. In that sense, young tenants prefer to live near a shopping center, making a shopping center one of their top priorities when looking for temporary accommodation. Similarly, it is reasonable that a living community near a hospital benefits from medical services, contributing to the higher PHRP. Usually, those who rent near the hospital are patients and their accompanying family members, so living near the hospital can satisfy tenants' demand for medical resources.

Moreover, it is worth noticing that some commonly recognized *architectural* factors in the existing literature did not have a significant impact on PHRP in Chongqing. Floor level and housing orientation, two significant elements of *Architectural Structure*, had almost no absolute effect on PHRP.

There is no obvious relationship between the floor level and PHRP in Chongqing. A common misconception about PHRP is that rent climbs with the height of the floor level [22], which, however, is not applicable in Chongqing. The reason behind this unusual occurrence is that the discrepancy in elevation in Chongqing offsets the benefits of living on higher floors with better privacy, which is a common preference of tenants in plain cities [29].

The orientation of the residential building had almost no effect on its PHRP in the mountainous city, even though the orientation of buildings had historically played a significant role in Chinese traditional culture. Traditionally, the south-facing nature of the master room is the most respected direction by Chinese people not only because of the longest daylight hours and good ventilation but also because of its good morale in traditional Chinese culture geomancy—Fengshui [38]. However, tenants' preference for south-facing housing was not obvious in Chongqing due to the objective limitation of geography. On the design aspect, the south orientation is not easy to be always ensured when the architectural design needs to be settled while coordinating with the complex mountainous geographic features of Chongqing. On the occupant aspect, the north-facing and south-facing housing developments in plain Chinese cities enjoy the coolest indoor temperature in summer due to favorable natural wind ventilation and the best natural lighting in winter. This practical advantage of the south orientation, however, cannot be achieved due to the blockage of the mountainous terrain in Chongqing. As previously stated, the PHRP of Chongqing reflect an insensitivity to the housing orientation, which contrasts with the situation in most plain Chinese cities.

5.2. Spatial Pattern of the PHRP's Determinants in Chongqing

A distinct spatial pattern of the determinants of PHRP has been revealed from MGWR analysis results, echoing the polycentric geographic feature of Chongqing city. Strong spatial heterogeneity effects were observed regarding the influential factors of Traffic, Neighborhood, and Architectural, whereas other influential factors of Neighborhood and Architectural indicated spatial homogeneity in forming PHRP (as shown in Table 12).

Table 12. Spatial heterogeneity of the influential factors in different functional zones.

Category	Influential Factors	Educational Zone	Industrial Zone	Commercial Zone	Financial Zone
Traffic condition	Subway		***		***
	Bus		***		***
Neighborhood environment	School	***			
	Shopping			***	
Architectural structure	Parking		***		***

Note: "***" indicates a strong spatial heterogeneity effect of the influential factor.

(1) Variability of influential factors in different functional zones of Chongqing

1) Spatial heterogeneity of the Traffic condition factors

In depicting the rental prices of Chongqing's private housing, Subway and Bus revealed strong spatial heterogeneity, playing more dominant roles in both the industrial zone (Yubei district) and financial zone (Yuzhong district) than in the other districts. In other words, Subway and Bus affect PHRP more significantly in the industrial zone and financial zone in contrast with other zones, which is consistent with the existing academic viewpoint [49]. Naturally, the industrial and financial zones aggregate a large number of migrant people who are well-educated with decent white-collar jobs. These newcomers generally choose to rent housing in the district where they work; even if the rental location is far from their workplace, they alternatively choose a location closer to public transportation for ease of commuting.

2) Spatial heterogeneity of the Neighborhood environment factors

The critical neighborhood environment factors (school and shopping) exhibit significant spatial heterogeneity in affecting the PHRP of Chongqing. This finding is consistent with the viewpoint of Henry George Theorem, which contends that quasi-public resources bring benefits to the residents and raise the local housing prices.

Distance to school showed a significant influence on PHRP in the educational zone of Chongqing. In China, it is a common phenomenon that zones with excellent educational resources attract families with children who rent close to schools, resulting in the exorbitant prices of housing around. In particular, the vast demands for school district housings lead to higher PHRP in the educational zone.

The Shopping of the Neighborhood environment reveals significant spatial heterogeneity in a commercial zone that is consistent with a previous study [38]. Compared with the other districts in Chongqing, the better shopping options and the more entertainment activities in the commercial zone (Jiangbei district) attract the new generations who prefer fun. In other words, living closer to the commercial zone is more attractive to the younger generation of tenants, driving the rents higher than in other districts.

3) Spatial heterogeneity of the Architectural Structure factors

Parking is an architectural structure that represents greater spatial heterogeneity in the industrial zone (Yubei district) and financial zone (Yuzhong district) of Chongqing, which is consistent with the previous study [30]. For most young white-collar workers in the industrial zone and financial zone, owning a private car has become a common occurrence. Considering the parking problem, most car owners prefer to live in a community with a parking space.

(2) Spatial homogeneity of influential factors in different functional zones of Chongqing

The Hospital and Restaurant factors of a Neighborhood environment exhibit non-spatial heterogeneity in this study. The hospital distributes its influence on PHRP evenly across eight districts of Chongqing, which appears to violate the law of the Henry George Theorem. This unusual phenomenon makes sense when viewed through the lens of traditional Chinese culture. Most Chinese are reluctant to live near hospitals; in terms of Chinese geomancy, Fengshui, the hospital symbolizes unhealthy whether for the young or the elderly. The Restaurant factor does not show spatial heterogeneity in affecting PHRP. Restaurant is not a scarce resource in the same way that educational resources are, and the commercial value of the housing near Restaurants is not high [34,37]. Similarly, the prevalence of Restaurants' distribution in Chongqing results in non-spatial heterogeneity in their impact on surrounding rent.

Architectural structures represent spatial homogeneity in Chongqing. Regardless of the location, it is a general truth that PHRP increases as the area expands. When all the other factors influencing PHRP remain unchanged, PHRP will be determined by the floor area of housing [38].

5.3. Practical Implications

(1) The local government of Chongqing should address the most concerned needs of the floating population by providing better public services in transportation and health care. First, it is suggested that the local government improves traffic accessibility by scientifically improving the coverage of the subway and bus lines. This study emphasized tenants' top priorities for proximity to subway and bus stations, reflecting the vital demand for public transportation in high-density cities. The "15-min walk of life circle" should be formed by scientifically planning public transportation facilities stations in close collaboration with the urban planning and transportation departments. Second, we recommend that the local government make greater efforts to provide sufficient medical services, according to the discovery of spatial homogeneity of hospitals across all districts/zones of the city. It reflects how medical services are commonly needed by all citizens, regardless of where they live or whether they are permanent or temporary residents. The vital impact of the availability of medical services on PHRP necessitates an equitable governmental planning strategy for distributing medical resources to ensure the city's housing rental market develops in a balanced manner.

(2) The housing rental agencies are suggested to obtain the housing by fully considering the diverse preferences of the tenants from different function zones. The majority of housing rental agencies in China are private companies that have their strategies to develop or collect housing from the market. They, however, do not regard the function of the zone as the most critical consideration for strategy making. In other words, spatial heterogeneity is not well understood and exploited to maximize their profits. This study recommends those housing rental agencies collect more rental properties near the schools in the educational zone and obtain more rental housing close to shopping centers in the commercial zone. This strategy will benefit both the housing rental agencies and the tenants by improving the investment value and meeting specific accommodating demands, respectively.

(3) Tenants in Chongqing, especially newcomers, are suggested to pay more attention to the transportation and service facilities nearby rather than the floor level and orientation of the rooms. This seemingly perverse suggestion is derived from the discovery that south

orientation and higher floor level do not bring the expected benefits of more sunlight and better privacy due to its unique terrain and climate. In comparison to the tenants' top demands on the architectural attributes in plain city, it is more important for people in mountain cities to pay higher rents to obtain better access to transportation and public service.

6. Conclusions

The private housing rental market has been developing quickly and has demonstrated its outstanding contribution, coping with the public housing, in improving affordability for residents in China. Affordable private rental housing has alleviated housing issues for some newcomers in the metropolis. This phenomenon has attracted increasing attention in the housing rental field [22]. However, few kinds of research comprehensively revealed the forming rules of the PHRP and the spatial pattern of PHRP determinants. Moreover, due to the previous lack of open data sources, an in-depth study on such issues is very insufficient. The purpose of this study is to provide comprehensive research on PHRP and the spatial pattern of its determinant factors based on real-time big data in a typical high-density mountainous Chinese city.

Python 3.8.0 was adopted to crawl the data of the factors that influence PHRP in Chongqing in January 2021. The data from eight central urban districts of Chongqing were gathered from two most popular rental platforms—Lianjia.com and 58.com. An MGWR model was used for analyzing the determinants of PHRP and the influential factors' spatial heterogeneity. The private housing rental market is shaped by architectural structure, traffic conditions, and neighborhood environment. Three significant forming rules of PHRP were revealed: (1) The closer distance to the bus and metro station positively raises the PHRP, verifying the argument that transportation facilities add great value to housing in densely populated cities. (2) The convenient neighborhood environment increases PHRP in supplying scarce social resources, as evidenced by the factors of school and shopping center. (3) The architectural structure, such as floor level and orientation, does not show obvious influential effects in high-density mountain cities as it does in plain cities.

Based on this, the MGWR analysis further investigated how the influence of the determinants on PHRP is differentiated across functional zones. Being identified as the local factors, the distance to schools and shopping centers presented a significant influence on the PHRP in the educational and commercial zone. The Subway and Bus factors affect traffic conditions and also showed strong spatial heterogeneity, playing a more dominating role in the industrial and financial zones. The hospitals and restaurants of the neighborhood environment were clustered into a global factors group, indicating non-spatial heterogeneity in influencing PHRP. Accordingly, practical recommendations are provided for local governments, rental agencies, and tenants to meet market demands.

Methodologically, a deepening research process provides valuable and reliable findings based on a solid theoretical framework, detailed data from extensive samples, and an MGWR analysis revealing the spatial variance. Compared with existing literature, this study investigates the determinants of PHRP by fully considering the heterogeneity across regions within a city. This study demonstrates its authenticity by engaging real-time big data, which eliminates the limitation of many previous studies with small samples and surveyed data.

Theoretically, this study contributes to uncovering the spatial pattern of the determinants of PHRP in high-density population cities. In addition, a combined application of the theories, Hedonic Price Theory, Bid Rent Theory, and Henry George Theory, extends the pool for identifying the influencing factor of the PHRP. Practically, this study inspires both the supply and demand sides. For the supply side, it helps the housing rental agencies obtain insight into the primary preferences of tenants, and it assists them in developing housing properties by fully considering the spatial characteristics of PHRP's determinants. The local government is suggested to increase the coverage of subway and bus lines in its municipal plans. For the demand side, the floating population is reminded to pay

more attention to transportation and service facilities rather than the floor level and the orientation when renting in highly dense populated mountainous cities. A comprehensive examination of the determinants and their spatial patterns in the study not only bridges the literature weakness of how PHRP is formed in high-dense populated cities but also inspires future housing price studies in the emerging metropolis.

This paper does, however, have limitations. First, due to the short period of the data, the time factor (low and high seasons) may have a certain degree of impact on PHRP. Data with a long-time span are unavailable due to the rapid update of data on Lianjia.com (accessed on 15 January 2021) and 58.com (accessed on 15 January 2021). Attempts could be made in the future to analyze the influential factors of rent using data with a long-time horizon. Second, macro-level influences that were not considered in this study may have an impact on rent. This study focuses on the impact of micro-level data on rent while ignoring the macro-level impact on rent. Future research can look at the factors that influence rent at both macro- and micro-levels.

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Note

[1] Available online: https://cq.lianjia.com/zufang/rs/; http://cq.58.com/chuzu/ (accessed on 1 October 2022).

References

1. C.R.E.I. China Real Estate Information. 2021. Available online: http://www.crei.cn/ (accessed on 15 January 2021).
2. Gao, X.; Wang, Z.; Cao, M.; Liu, Y.; Zhang, Y.; Wu, M.; Qiu, Y. Neighbourhood satisfaction in rural resettlement residential communities: The case of Suqian, China. *Hous. Stud.* **2022**, *37*, 1497–1518. [CrossRef]
3. Kettunen, H.; Ruonavaara, H. Rent regulation in 21(st)century Europe. Comparative perspectives. *Hous. Stud.* **2021**, *36*, 1446–1468. [CrossRef]
4. Shi, W.; Chen, J.; Wang, H. Affordable housing policy in China: New developments and new challenges. *Habitat Int.* **2016**, *54*, 224–233. [CrossRef]
5. Hui, E.C.M.; Wang, Z.Y. Price anomalies and effectiveness of macro control policies: Evidence from Chinese housing markets. *Land Use Policy* **2014**, *39*, 96–109. [CrossRef]
6. Timberlake, M.; Wei, Y.D.; Ma, X.; Hao, J. Global cities with Chinese characteristics. *Cities* **2014**, *41*, 162–170. [CrossRef]
7. Ayouba, K.; Breuille, M.L.; Grivault, C.; Le Gallo, J. The spatial dimension of the French private rental markets: Evidence from microgeographic data in 2015. *Environ. Plan. B Urban Anal. City Sci.* **2021**, *48*, 2497–2513. [CrossRef]
8. Li, P.; He, X.; Li, Y.; Xiang, G. Occurrence and health implication of fluoride in groundwater of loess aquifer in the Chinese loess plateau: A case study of Tongchuan, northwest China. *Expo. Health* **2019**, *11*, 95–107. [CrossRef]
9. Todd, J.; Musah, A.; Cheshire, J. Assessing the impacts of Airbnb listings on London house prices. *Environ. Plan. B Urban Anal. City Sci.* **2022**, *49*, 206–222. [CrossRef]
10. C.R.E.I. China Real Estate Information. 2018. Available online: http://www.crei.cn/ (accessed on 15 January 2018).
11. Xiong, S.; Wu, Y.; Wu, S.; Chen, F.; Yan, J. Determinants of migration decision-making for rural households: A case study in Chongqing, China. *Nat. Hazards* **2020**, *104*, 1623–1639. [CrossRef]
12. Shao, X.; Cao, Y.; Teng, Y.; Chen, J.; Gong, L. The Consumption-Stimulating Effect of Public Rental Housing in China. *China World Econ.* **2022**, *30*, 106–135. [CrossRef]
13. Huang, Y. Low-income housing in Chinese cities: Policies and practices. *China Q.* **2012**, *212*, 941–964. [CrossRef]
14. Beenstock, M.; Felsenstein, D.; Xieer, D. Long-term housing affordability in spatial general equilibrium. *Hous. Stud.* **2021**, *36*, 935–968. [CrossRef]
15. Tomal, M.; Helbich, M. The private rental housing market before and during the COVID-19 pandemic: A submarket analysis in Cracow, Poland. *Environ. Plan. B Urban Anal. City Sci.* **2022**, *49*, 1646–1662. [CrossRef]

16. Jiang, L.; Lai, Y.; Chen, K.; Tang, X. What Drives Urban Village Redevelopment in China? A survey of Literature Based on Web of Science Core Collection Database. *Land* **2022**, *11*, 128–137. [CrossRef]
17. Kim, A. The extreme primacy of location: Beijing's underground rental housing market. *Cities* **2016**, *52*, 148–158. [CrossRef]
18. Liu, Y.; He, S.; Wu, F.; Webster, C. Urban villages under China's rapid urbanization: Unregulated assets and transitional neighborhoods. *Habitat Int.* **2010**, *34*, 135–144. [CrossRef]
19. Bencardino, M.; Nestico, A. Demographic changes and real estate values. A quantitative model for analyzing the urban-rural linkages. *Sustainability* **2017**, *9*, 536–555. [CrossRef]
20. Hu, Y.; Lu, B.; Ge, Y.; Dong, G. Uncovering spatial heterogeneity in real estate prices via combined hierarchical linear model and geographically weighted regression. *Environ. Plan. B Urban Anal. City Sci.* **2022**, *49*, 1715–1740. [CrossRef]
21. Polloni, S. Traffic calming and neighborhood livability: Evidence from housing prices. in Portland. *Reg. Sci. Urban Econ.* **2019**, *74*, 18–37. [CrossRef]
22. Li, H.; Wei, Y.D.; Wu, Y.Y. Analyzing the private rental housing market in Shanghai with open data. *Land Use Policy* **2019**, *85*, 271–284. [CrossRef]
23. Lancaster, K.J. A new approach to consumer theory. *J. Political Econ.* **1966**, *74*, 132–157. [CrossRef]
24. Rosen, S. Hedonic prices and implicit markets-product differentiation in pure competition. *J. Political Econ.* **1974**, *82*, 34–55. [CrossRef]
25. Alonso, W. Location and land use: Toward a general theory of land rent. *Econ. Geogr.* **1964**, *42*, 326–327.
26. Turnbull, G.K.; Zahirovic-Herbert, V.; Zheng, M.R. Uncertain school quality and house prices: Theory and empirical evidence. *J. Real Estate Financ. Econ.* **2018**, *57*, 167–191. [CrossRef]
27. Liang, X.; Liu, Y.; Qiu, T.; Jing, Y.; Fang, F. The effects of locational factors on the housing prices of residential communities: The case of Ningbo, China. *Habitat Int.* **2018**, *81*, 1–11. [CrossRef]
28. Lu, J.J. The value of a south-facing orientation: A hedonic pricing analysis of the Shanghai housing market. *Habitat Int.* **2018**, *81*, 24–32. [CrossRef]
29. Xiao, Y.; Hui, E.C.; Wen, H.Z. Effects of floor level and landscape proximity on housing price: A hedonic analysis in Hangzhou, China. *Habitat Int.* **2019**, *87*, 11–26. [CrossRef]
30. Yin, J.J.; He, Y.L.; Sun, X.D. Evaluation method of influence region of parking lot based on entropy method. *J. Interdiscip. Math.* **2018**, *21*, 1363–1368. [CrossRef]
31. Huang, Z.Z.; Chen, R.s.; Xu, D.; Wei, Z. Spatial and hedonic analysis of housing prices in Shanghai. *Habitat Int.* **2017**, *67*, 69–78. [CrossRef]
32. Yang, L.; Chu, X.; Gou, Z.; Yang, H.; Lu, Y.; Huang, W. Accessibility and proximity effects of bus rapid transit on housing prices: Heterogeneity across price quantiles and space. *J. Transp. Geogr.* **2020**, *88*, 236–256. [CrossRef]
33. Zou, Y.H. The effects of double-attendance zones and school rankings on housing prices: Case of Nanjing, China. *J. Urban Plan. Dev.* **2022**, *148*, 235–255. [CrossRef]
34. Zheng, S.Q.; Kahn, M.E. Does government investment in local public goods spur gentrification? Evidence from Beijing. *Real Estate Econ.* **2013**, *41*, 1–28. [CrossRef]
35. Yang, L.C.; Chau, K.W.; Wang, X. Are low-end housing purchasers more willing to pay for access to basic public services? Evidence from China. *Res. Transp. Econ.* **2019**, *76*, 11. [CrossRef]
36. Wu, C.; Ye, X.; Du, Q.; Luo, P. Spatial effects of accessibility to parks on housing prices in Shenzhen, China. *Habitat Int.* **2017**, *63*, 45–54. [CrossRef]
37. Hu, L.R.; He, S.J.; Han, Z.X.; He, X.; Su, S.; Weng, M.; Cai, Z. Monitoring housing rental prices based on social media: An integrated approach of machine-learning algorithms and hedonic modeling to inform equitable housing policies. *Land Use Policy* **2019**, *82*, 657–673. [CrossRef]
38. Li, H.; Wei, Y.D.; Wu, Y.; Tian, G. Analyzing housing prices in Shanghai with open data: Amenity, accessibility and urban structure. *Cities* **2019**, *91*, 165–179. [CrossRef]
39. Wen, H.Z.; Zhang, Y.; Zhang, L. Do educational facilities affect housing price? An empirical study in Hangzhou, China. *Habitat Int.* **2014**, *42*, 155–163. [CrossRef]
40. Xi, H.; Tang, L.; Feng, C.C. Research on the Measurement Method of Benchmark Price of Rental Housing. *Land* **2022**, *11*, 47–53. [CrossRef]
41. Geniaux, G.; Martinetti, D. A new method for dealing simultaneously with spatial autocorrelation and spatial heterogeneity in regression models. *Reg. Sci. Urban Econ.* **2018**, *72*, 74–85. [CrossRef]
42. McCord, M.; Davis, P.; Haran, M.; McIlhatton, D.; McCord, J. Understanding rental prices in the UK: A comparative application of spatial modeling approaches. *Int. J. Hous. Mark. Anal.* **2014**, *43*, 231–243. [CrossRef]
43. Du, Q.; Wu, C.; Ye, X.; Ren, F.; Lin, Y. Evaluating the effects of landscape on housing prices in urban China. *Tijdschr. Voor Econ. En Soc. Geogr.* **2018**, *109*, 525–541. [CrossRef]
44. Jun, H.J. Spillover effects in neighborhood housing value change: A spatial analysis. *Hous. Stud.* **2022**, *37*, 1303–1330. [CrossRef]
45. Fotheringham, A.S.; Yang, W.B.; Kang, W. Multiscale Geographically Weighted Regression (MGWR). *Ann. Am. Assoc. Geogr.* **2017**, *107*, 1247–1265. [CrossRef]
46. Yu, H.; Fotheringham, A.S.; Li, Z.; Oshan, T.; Kang, W.; Wolf, L.J. Inference in multiscale geographically weighted regression. *Geogr. Anal.* **2020**, *52*, 87–106. [CrossRef]

47. Liao, D.; Zhu, H.; Jiang, P. Study of urban heat island index methods for urban agglomerations (hilly terrain) in Chongqing. *Theor. Appl. Climatol.* **2021**, *143*, 279–289. [CrossRef]
48. Marquardt, D.W. Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation. *Technometrics* **1970**, *12*, 591–612. [CrossRef]
49. Payson, D.B.; Frolov, I.E. Multi-level structure of the international space market and analysis of labor productivity in the rocket and space industry. *Cosm. Res.* **2020**, *58*, 218–226. [CrossRef]