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Tenure-Based Housing Spatial Patterns and Residential Segregation in Guangzhou under the Background of Housing Market Reform

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Abstract: China's urban housing distribution system has been transformed from a redistribution system to a market-oriented distribution system, which has profoundly affected the ways and opportunities for urban residents to obtain housing resources and has triggered a large-scale reconstruction of urban residential social space. Based on the national 5th and 6th census data of Guangzhou, this paper analyzes the spatial patterns of housing tenure and tenure-based residential segregation in 2000 and 2010 with the research aim of analyzing the internal logic of urban housing distribution and residential segregation in urban China using Guangzhou as an example. The study finds that the home ownership rate in Guangzhou dropped from 62.31% in 2000 to 49.72% in 2010, with the percentage of social housing particularly low. The index of evenness and concentration is used to analyze tenure-based residential segregation. The results show that the tenure-based residential segregation index in 2000 and 2010 is between 0.4 and 0.6, which implies that residential segregation is basically moderate and that social housing is more segregated than open market housing. On the whole, market mechanisms have gradually played a fundamental role in tenure-based residential restructuring and segregation since 2000, and governmental and institutional factors also significantly influence such elements.

Keywords: spatial patterns; housing spatial restructuring; residential segregation; Guangzhou

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1. Introduction

In recent years, China's urban housing system and urbanization have developed rapidly, resulting in substantial changes and spatial restructuring in urban housing tenure [1,2]. China's housing reform began in the 1980s, with the aim of stimulating economic growth and improving people's living conditions through privatization and marketization of housing supply and consumption. In 1998, State Council promulgated the policy on "further deepening urban housing system reform and speeding up housing construction", intending to realize urban housing marketization, socialization, and commercialization progressively and to increase the pace of housing marketization reform. This policy proposed fully suspended material distribution and implemented monetary housing allocation, fully implementing and continuously improving the system of housing supply. The policy aimed to establish and improve a housing supply system based on low-income housing; that is, low-income families rent low-cost rental housing provided by the government, middle-income families buy affordable housing, and high-income households buy or rent commercial housing at market prices.

Diversity characterizes the structures of both urban housing provision and housing tenure in transitional urban China. Such housing structures include social housing (e.g., cheaper rental housing, economical and suitable housing, and purchased original social housing) and open-market housing (e.g., commodity housing and second-hand housing) dominated by the forces of housing redistribution and marketization, respectively. The options of housing for residents are multiple, but their access to social housing is

strictly limited to a certain group with local *hukou* registration or working in stated enterprises. In this case, the work units or local governments act as the judge and are the ones responsible for developing the allocation. Application requirements for economical and suitable housing and cheaper rental housing are determined by local government, and income and household registration are often the basic requirements in order to raise the threshold of application. Purchased original social housing has the limitation of the nature of the work unit and length of working service for occupiers, and only those who work in stated enterprises (government organization, state-owned enterprises, and *shiye* enterprises) are qualified to purchase such housing. In fact, stated enterprises stopped selling public housing (or *danwei* housing) as a result of the implementation of market-oriented housing reform in 1998. Meanwhile, commodity housing is restricted by the financial capability of each household. After 2006, housing prices rapidly increased in large Chinese cities (Beijing, Guangzhou, and Shanghai) due to excessive housing marketization, and the economic threshold of purchased commodity housing became even higher. This situation implies that more significant differences for the approaches and opportunities of obtaining scarce housing resources emerged for different social groups, with market capacity and policy means further intensifying residential differentiation on a large scale. Such a differentiation is expected to further affect social status and the promotion of social classes of urban residents in accordance with housing and access to associated opportunities (such as access to educational resources and other opportunities). Housing has increasingly become the symbol of one's social status and an important standard for classifying social classes.

Guangzhou is a representative city of higher marketization and economic development in coastal China. Since 2000, the factors that affect the urban housing spatial restructuring of this city have greatly changed. Firstly, Guangzhou began to thoroughly implement housing marketization in 1998, and subsequently, the internal logic of its housing distribution mechanism was fundamentally transformed into a market-oriented distribution system. Thus far, the degree of housing marketization of this city has substantially increased and even entered into the stage of excessive marketization. This transformation has deeply influenced the housing choices of urban residents and the urban residential spatial structure. Secondly, similar to the case of most of other large cities in China, the housing prices in Guangzhou have substantially increased, its housing investment potential has greatly escalated since 2006, and owning a house in such a city has become an important part of the wealth of its urban residents; housing has become more and more important index for classifying social classes. Finally, the period from 2000 until now is considered a period of rapid development of housing construction and urbanization in Guangzhou, in which urban construction land has extensively expanded to the suburbs, the central city has experienced large-scale urban renovation, and real estate has been developed into central and suburban cities. The primary development that transpired in Guangzhou is that its market has become the basic force for urban restructuring and has profoundly affected and changed its tenure-based housing spatial patterns and residential segregation.

The phase of 2000–2010 was a decade in which China's big cities experienced housing system reform; housing prices rose significantly, and residential space underwent large-scale reconstruction. The existing studies lack the analysis of the changes in the internal logic of housing distribution and the resulting residential segregation in China's big cities since the reform of China's housing system in 1998, especially under the background of China's rapid housing marketization in the 10 years from 2000 to 2010. Therefore, taking Guangzhou as a case, this paper analyzes the changes in the housing distribution mechanism and the degree of tenure-based residential segregation in China's big cities on the micro scale, and thus it can enrich the existing research.

The 5th (2000) and 6th (2010) small areas (sub-district or town) census data of Guangzhou, with housing-related variables, provide the latest data for comprehensively analyzing the tenure-based housing spatial patterns and spatial segregation after 2000. Thus, this paper uses the 5th (2000) and 6th (2010) census data to analyze the evolution of tenure-based residential segregation. This study will help to understand the implementation effect of

China's urban housing system reform and its impact on the reconstruction of residential space. The rest of the paper is organized into five sections. Following the introduction, Section 2 reviews the related literature on tenure-based housing choice and residential segregation. Section 3 presents the analyses of data sources and methods. Section 4 specifies the changes in housing tenure structure, compares the differences of tenure-based housing spatial patterns with the location quotient in 2000 and 2010, and uses the dimensions of residential segregation to measure and compare the degree of tenure-based residential segregation during this period. Finally, Section 5 concludes the study.

2. Tenure-Based Housing Choice and Residential Segregation: A Review

2.1. Tenure-Based Housing Choice

Western research on housing tenure choice can be classified into two kinds of research approaches (economic approach and sociodemographic approach) under a free housing market. In the economic approach, housing tenure choice is hypothesized to be economically rational and budget-constrained for utility maximization [3]. Consequently, housing tenure choice involves not only consumption decision making, but more importantly, investment decision making within a highly competitive housing market, and income, assets, and relative prices are considered as the most important factors affecting housing tenure change and housing conditions [4,5]. The applications of the sociodemographic approach in the fields of geography, planning, and sociology relate housing tenure choice with the social and economic characteristics of a household and emphasize the important impacts of factors such as household structure, job rank, and income on housing tenure choice [6,7].

Research on housing tenure choice has increasingly emphasized the analysis of longitudinal datasets and focused on how housing choices are intertwined with decisions about familial status, job access, and the whole set of decisions that are encapsulated by the notion of the life course approach [8]. More and more research uses the life course approach and event-history method to study housing tenure choice, especially for the switch from renting to owning [9,10].

Post-socialist cities, such as the cities of Central and Eastern Europe (CEE), the former Soviet Union, and urban China, have experienced socio-economic transition and increasing socio-spatial differentiation among different social groups [11,12]. In China, as the largest developing country in the world, the transformation from a planned economy to a market economy and its influence on urban development has attracted many scholars. Wider research about China's housing mainly focuses on the aspects of housing reform and its social and spatial impacts, housing choice behavior in transitional urban China, housing inequality and residential differentiation, and even segregation. Many researchers have focused on the social and spatial impacts of housing reform in urban China since 1980 [13,14]. Urban housing reform has changed the housing provision structure and also created new housing inequality and differentiation and even segregation. Housing reform has made substantial progress in lessening housing shortages, but housing inequality still exists and has become even worse [15,16]; the biggest winners in China's transition from socialist housing allocation are those who were favored in the previous system, based on such factors as residence status, education, and occupation [17]. Although China has made great strides in improving housing provision, it is still plagued by a lack of affordable housing, and contradictions in China's affordable housing policy and the intergovernmental structures have become a barrier to affordable housing provision [18].

The housing market in transitional urban China is quite different from that in a mature market economy or in a fully planned economy; it is a combination of both, reflecting certain characteristics of each system. Consequently, housing tenure choices in transitional urban areas are complex, with the characteristics both socio-economic factors, such as household income and life cycle, and institutional variables such as hukou, job rank, and work unit rank playing important roles in residents' housing behavior. China's housing distribution became a hybrid system, having both market and socialist (institutional) characteristics [19], and residents in open market housing generally have higher incomes and hold higher-

status jobs than those in the subsidized sectors [20]. The life course approach has been applied to research on China's urban housing. Using the longitudinal dataset collected in big cities such as Guangzhou, Beijing, and Shanghai, and using the life course approach, housing tenure change [21] and residential mobility [22] in transitional urban China have been analyzed. Recent research on housing in urban China has paid increasing attention to housing behavior among specific groups, including gated communities [23], second home-ownership [24], and the concentration of the urban poor [25].

2.2. Tenure-Based Residential Segregation

Research on residential segregation has devoted attention to residential segregation among different races and classes [26,27] and even among different religious groups, such as Muslim religious groups [28], and school segregation [29]. In recent years, the degree of residential segregation in some European and American countries has been increasing. Studies have shown that according to income segregation, the diversity index of 340 cities in the United States has increased from 0.30 in 1980 to 0.35 in 2010 [30]. Manley et al. believes that there is a downward trend in ethnic residential segregation in Auckland, New Zealand [31]. At the same time, residential segregation is also related to research scale, and the smaller the spatial scale, the greater the degree of residential segregation [32]. There is also related research on housing deprivation and housing inequality in Western European countries (e.g., [33]).

The segregation studies often use the segregation index to measure the degree of segregation; the segregation index changed from the early diversity index (dissimilarity index) [34] to multi-dimension segregation indices [35], and multi-group segregation indices [36], and to the development of the widely used GIS tool to modify the segregation indices (e.g., [37]). The measure of residential segregation is also related to the spatial scale. In order to overcome the modifiable area unit problem (MAUP) in the measure of residential segregation, Reardon et al. provided a scale-sensitive measure by analyzing the spatial aggregation profiles and the ratio of macro to micro aggregation [38]. Generally speaking, the measure of residential segregation has entered the stage of multi-dimensional and multi-scale measures, but the traditional dissimilarity index is still an important and effective measurement indicator.

China's rapid globalization, industrialization, and urbanization inevitably brought about increasing social division and spatial differentiation. Socio-spatial differentiation has increasingly become one of the hot research topics. Relative research often uses small area census data and uses ecological factor analysis to classify social space in China's big cities, including Beijing [39], Shanghai [40], and Guangzhou [41,42]. Because using the sub-districts as basic spatial units to analyze social area often ignores more subtle social space within the sub-district, some literature uses community-level census data to analyze social areas [43].

In recent years, with the intensification of the differentiation of social structure and urban social space in big Chinese cities, the specific social space has attracted the attention of scholars. The urban village is a typical social space in large cities in China and is a social space for the concentration of floating populations [44–46]. The income gap of residents in China's big cities continues to expand; low-income groups gather in cities and form poverty spaces, with the stratification trend of urban spaces becoming more and more obvious [47,48]. For the sake of management and safety, etc., gated communities have become the dominant mode of newly built residential communities in large cities in China in recent years, which has exacerbated the degree of residential segregation to a certain extent [49,50]. With the increasing openness of Chinese cities to the outside world, there are a variety of multinational immigrant communities in Chinese big cities under the background of globalization [51].

The period from 2000 to 2010 saw in-depth development of housing marketization in Guangzhou. In terms of this phase, previous research provided insufficient overall descriptions of the tenure-based housing spatial patterns and residential segregation. Reviewing

previous studies, the current research aims to analyze tenure-based housing spatial patterns and residential segregation under the background of the housing marketization since 2000, so as to provide a basis for analyzing the role of the housing market and the force of redistribution (or government) for housing spatial patterns remodeling and residential urban restructuring.

3. Data and Methodology

3.1. Data Source and Study Area

Official census data are frequently released only at the district and sub-district (or towns) levels, and only small-area statistics at the sub-district (or town) level are used in this research. Sub-districts are the lowest administrative units within the built-up urban area. Their size is roughly equal to that of a census tract in the United States. Meanwhile, towns are established in the urban periphery; their size is larger than that of a sub-district because of lower population densities. The study area covers the main urban areas of Guangzhou, comprising the districts of Yuexiu, Dongshan, Liwan, Tianhe, Fangcun, Baiyun, Haizhu, and Huangpu, with a total of 99 sub-districts or towns in 2000. In 2005, Guangzhou experienced administrative changes; as a result, Dongshan was merged with Yuexiu, Fangcun was merged with Liwan, and Huangpu was divided into Huangpu and Luogang. So, the seven new districts included Yuexiu, Liwan, Haizhu, Tianhe, Luogang, Baiyun, and Huangpu, with 117 sub-districts or towns in 2010 (Figure 1). Nevertheless, the difference in the overall research area is small and can be compared.

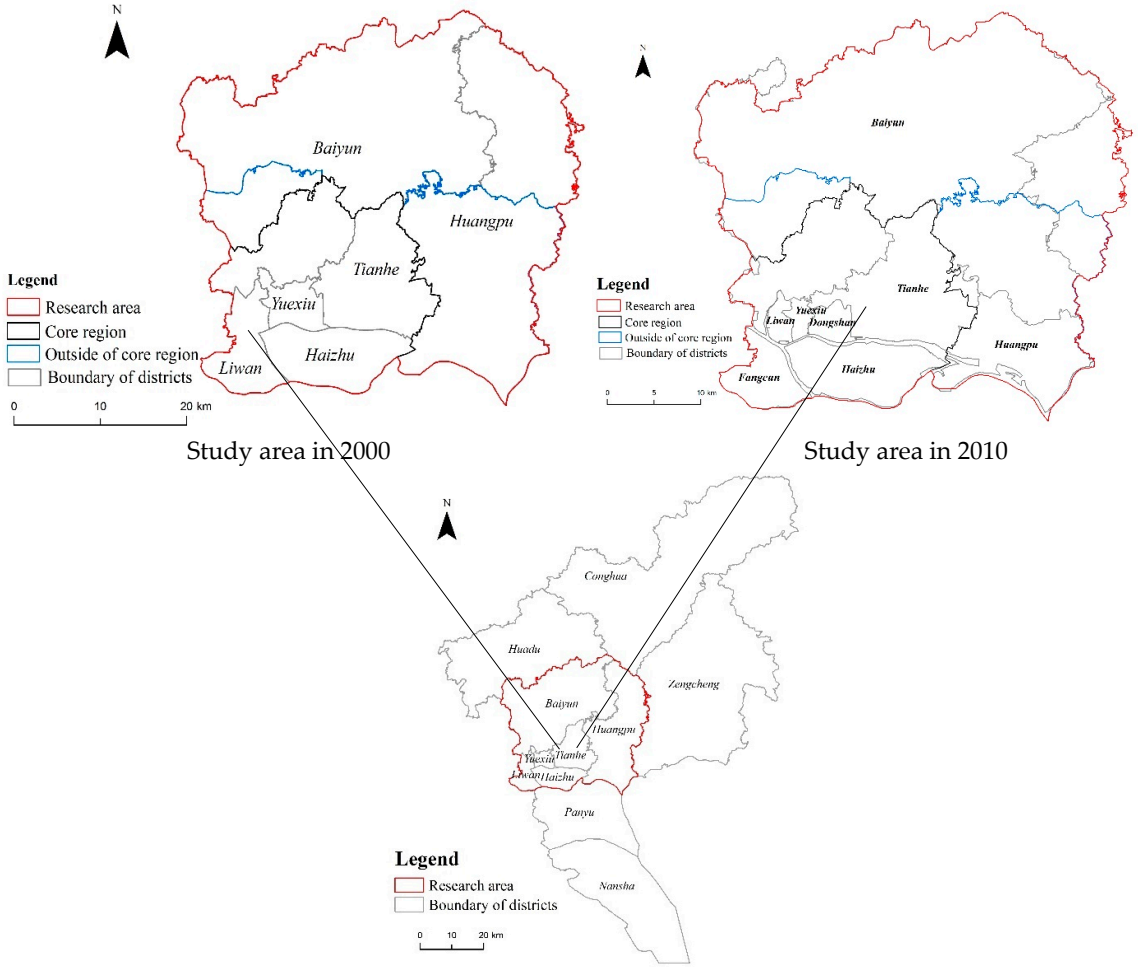

Figure 1. Study areas in 2000 and 2010.

The study area is the urban center of Guangzhou, which is a densely populated and industrial area. Households in the census in China are divided into family households and collective households. Family households are families living in one housing unit, while collective households are families living in collective dormitories, that is, several families live in one housing unit. According to Table 1, the population of Guangzhou increased from 9.94 million in 2000 to 12.70 million in 2010, an increase of 127.76%. The number of households increased from 2.82 million in 2000 to 4.33 million in 2010, an increase of 153.53%. The number of households increased from 2.38 million in 2000 to 3.79 million in 2010, an increase of 159.44%. It can also be seen that family households account for the main part of households; in 2000 and 2010, the percentage of family households of the total households was 84.17% and 87.41%, respectively. The number of housing units surveyed in the census increased from 0.23 million in 2000 to 0.37 million in 2010, an increase of 165.02%. In 2000 and 2010, the percentage of the total population, family household and total housing units surveyed in study area accounting for the whole of Guangzhou reached 62.17% and 63.78%, 66.07% and 67.88%, and 65.02% and 68.67%, respectively. Therefore, as the urban center of Guangzhou, the study area basically reflects the overall characteristics of Guangzhou.

Table 1. Basic statistics in study area.

Area	Population (Million)	Households (Million)	Family Households (Million)	Number of Housing Units Surveyed (Ten Thousand)
		In 5th Census		
Guangzhou	9.94	2.82	2.37	22.70
Study area				
Dongshan	0.56	0.17	0.16	1.58
Liwan	0.47	0.15	0.14	1.41
Yuexiu	0.34	0.11	0.10	1.00
Haizhu	1.24	0.38	0.33	3.18
Tianhe	1.11	0.34	0.26	2.28
Fangcun	0.32	0.09	0.08	0.79
Baiyun	1.75	0.48	0.39	3.57
Huangpu	0.39	0.13	0.10	0.95
Total (percentage in Guangzhou %)	6.18 (62.17%)	1.86 (65.82%)	1.57 (66.07%)	14.76 (65.02%)
		In 6th Census		
Guangzhou	12.70	4.33	3.79	37.46
Study area				
Liwan	0.89	0.33	0.30	2.81
Yuexiu	1.16	0.40	0.37	3.24
Haizhu	1.56	0.57	0.52	5.58
Tianhe	1.43	0.55	0.45	4.15
Baiyun	2.22	0.80	0.68	7.32
Huangpu	0.46	0.18	0.16	1.70
Luogang	0.37	0.13	0.10	0.94
Total (percentage in Guangzhou %)	8.10 (63.78%)	2.95 (68.23%)	2.57 (67.89%)	25.72 (68.67%)
Growth rate from 2000 to 2010	127.76%	153.53%	159.44%	165.02

3.2. Measurement

According to census statistics, tenure-based residential segregation in this paper refers to the extent of spatial differentiation of residents' housing tenure, including self-built housing, purchased commodity housing, purchased second-hand housing, purchased economical and affordable housing, purchased original social housing, cheaper rental housing, and other rental housing, and this spatial differentiation can reflect the degree of urban spatial division and social differentiation.

This paper attempts to analyze the residential segregation based on tenure-based housing spatial patterns. Tenure-based housing spatial patterns are conducive to the analysis of the centralized distribution pattern of all types of housing, while the residential

segregation can assess the overall extent of residential differentiation. "Location Quotients" (LQs), which represents the ratio of the proportion of each type of housing in each unit of the proportion of this type of housing in the whole study area, is an effective index to analyze the housing concentrated distribution pattern. Massey and Denton (1988) classify the types and spatial manifestations of segregation into five distinct dimensions: evenness, exposure, concentration, clustering, and centralization [35]. This paper mainly measures the tenure-based residential segregation from two aspects: the centralized distribution form of various houses and the spatial relationship between this form and the urban center from a single group and two groups; therefore, the paper selects the two dimensions of evenness and centralization calculated from a single group and two groups. The index of dissimilarity (ID) and centralization index are simple but practical and widely used dimensions of evenness and centralization; single group (Segregation index (IS) and Absolute centralization index (ACE)) and two groups (Index of dissimilarity (ID) and Relative centralization index (RCE)) are adopted to analyze the tenure-based residential segregation.

We use "Location Quotients" (LQs) to analyze the spatial pattern of housing tenure. The calculation formula for LQ is as follows:

$$\mathrm{LQ} = e_i / E_i, \qquad i = 1, 2, 3, \ldots, n.$$

where, e_i represents the percentage of certain kinds of housing tenure in unit i; E_i represents the percentage of certain kinds of housing tenure in the whole research area; the higher the location entropy is, the higher the degree of agglomeration.

This paper adopts the Segregation index (IS) and Index of dissimilarity (ID) in the evenness dimension, and the Absolute centralization index (ACE) and Relative centralization index (RCE) in the concentration dimension; the calculation formulas are as follows:

① Segregation Index (IS) [34].

$$\mathrm{IS} = \frac{1}{2}\sum_{i=1}^{n}\left|\frac{x_i}{X} - \frac{t_i - x_i}{T - X}\right|$$

② Absolute Centralization Index (ACE) [35].

$$\mathrm{ACE} = (\sum_{i=1}^{n} X_{i-1}S_i) - (\sum_{i=1}^{n} X_i S_{i-1})$$

For these, spatial units are sorted by distance from the city center in ascending order.

③ Index of Dissimilarity (ID) [34].

$$\mathrm{ID} = \frac{1}{2}\sum_{i=1}^{n}\left|\frac{x_i}{X} - \frac{y_i}{Y}\right|$$

④ Relative Centralization Index (RCE) [35].

$$\mathrm{RCE} = (\sum_{i=1}^{n} X_{i-1}Y_i) - (\sum_{i=1}^{n} X_i Y_{i-1})$$

For these, spatial units are sorted by distance from the city center in ascending order.

For the formulas above, X is the total population of group x in metropolitan area; x_i x_i is total population of group x in spatial unit i; Y is total population of group y in metropolitan area; y_i is total population of group y in spatial unit i; t_i is total population in spatial unit i; T is total population in the metropolitan area; S_i is cumulative percentage of area of spatial unit i (from 1 to i).

3.3. Analysis Framework

Housing tenure includes home ownership and housing type. Home ownership includes rental and purchased, while housing type includes self-built housing, purchased

commodity housing (including purchased second-hand housing), purchased economical and suitable housing, purchased original social housing, cheaper rental housing, and other rental housing. The Location quotient (LQ) is used to measure tenure-based housing spatial patterns, and the measures including IS, ID, ACE, and RCE are used to measure tenure-based residential segregation from the angles of one group and two groups. The analysis framework is shown in Figure 2.

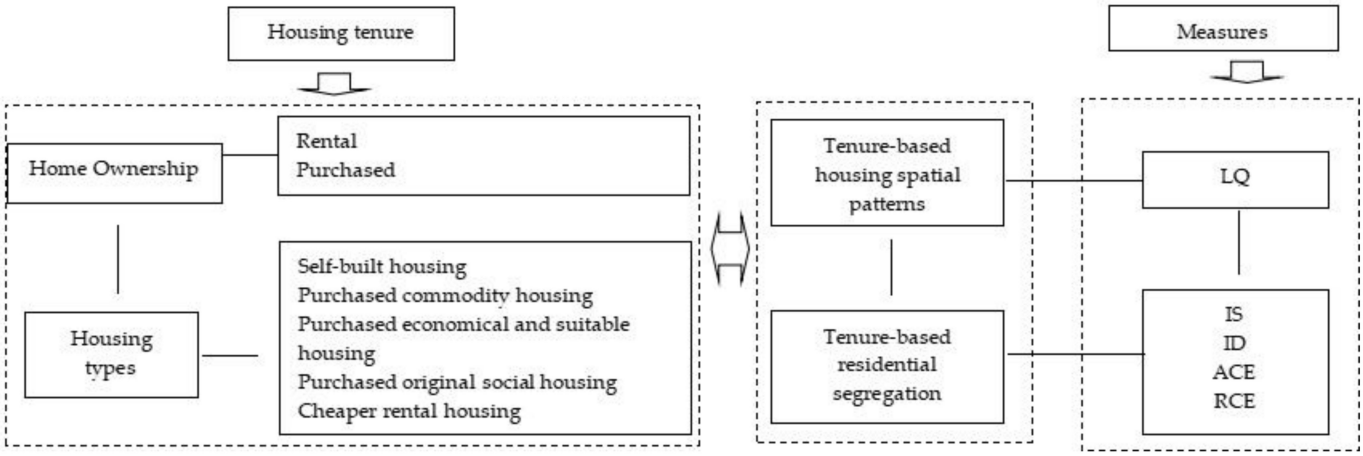

Figure 2. Analytical framework.

4. Tenure-Based Residential Segregation in Guangzhou

4.1. Changes in Housing Tenure Structure and Home Ownership Rate

(1) Changes in housing tenure structure

The basic statistical analysis of housing type structure in each district is shown in Table 2. The percentage of self-built housing, purchased commodity housing, purchased economical and suitable housing, purchased original social housing, rental social housing, rental commodity housing, and other housing were 20.58%, 8.08%, 2.89%, 31.62%, 16.01%, 14.58%, and 6.23% in the 5th census (2000) and 10.95%, 23.49%, 1.72%, 13.56%, 3.35%, 41.90%, and 5.03% in the 6th census (2010).

The housing type structure of the study area reflects similar characteristics to those of China's big cities, Beijing and Shanghai, and the whole of China; that is, the degree of housing marketization increased and the percentage of public housing decreased (Table 2). The percentage of purchased commodity housing in the study area increased from 8.08% in 2000 to 23.49% in 2010, while the corresponding percentage in all of China, Beijing, and Shanghai was 3.86% and 14.07%, 3.95% and 21.24%, and 9.86% and 31.22% respectively, reflecting a rapid upward trend. However, the total percentage of social housing in the study area, including purchased economical and suitable housing, purchased original social housing, and rental social housing, decreased from 50.52% in 2000 to 18.63% in 2010, while the corresponding percentage in all of China, Beijing, and Shanghai was 18.25% and 10.46%, 55.14% and 23.94%, and 52.66% and 16.64% respectively. The changes in housing type structure indicate that the degree of housing marketization in China increased significantly from 2000 to 2010 and the market became the main way for residents to obtain housing.

There are obvious regional differences in housing type structure in the study area. In 2000, the proportion of purchased original social housing and rental social housing was relatively high in central urban areas such as Dongshan District, Yuexiu District, and Liwan District. In particular, the percentage of purchased original social housing in Dongshan District reached 55.71%, while the proportion of this type of housing was relatively low in Baiyun District and Huangpu District, where the proportion of rental commercial housing was relatively high. In 2010, namely in the 6th census, the proportion of purchased original social housing and rental social housing in Dongshan District, Yuexiu District, and Liwan

District decreased significantly, while the proportion of purchased commodity housing and rental commodity housing increased significantly in the whole study area.

Table 2. Statistical table of housing type structure in the study area and other similar regions in China in 2000 and 2010.

Area	Self-Built Housing (%)	Purchased Commodity Housing (%)	Purchased Economical and Suitable Housing (%)	Purchased Original Social Housing (%)	Rental Social Housing (%)	Rental Commodity Housing (%)	Other Housing (%)	Total (%)	Home Ownership Rate (%)
				In 5th Census					
China	71.57	3.86	2.64	9.5	6.11	2.7	3.62	100	87.57
Beijing	31.21	3.95	2.13	27.93	25.08	6.41	3.29	100	65.22
Shanghai	26.63	9.86	3.95	22.1	26.61	5.63	5.22	100	62.54
Guangzhou	35.73	9.12	2.60	22.53	12.91	11.59	5.52	100	69.98
Study area									
Dongshan	4.04	3.8	0.97	55.71	22.52	3.54	9.42	100	64.52
Liwan	10.92	5.85	1.72	35.12	30.42	8.57	7.39	100	53.61
Yuexiu	8.92	3.07	1.43	37.32	33.82	7.34	8.11	100	50.74
Haizhu	14.05	10.44	3.18	36.89	15.76	15.11	4.56	100	64.56
Tianhe	15.63	11.45	3.72	36.12	3.92	21.64	7.51	100	66.92
Fangcun	26.35	9.34	3.19	24.56	19.18	9.79	7.6	100	63.44
Baiyun	41.26	8.7	4.15	13.65	10.49	17.54	4.21	100	67.76
Huangpu	25.8	4.36	1.48	25.52	13.08	23.61	6.16	100	57.16
Total	20.58	8.08	2.89	31.62	16.01	14.58	6.23	100	63.17
				In 6th Census					
China	62.31	14.07	2.18	6.83	1.45	10.5	2.66	100	85.39
Beijing	16.55	21.24	4.91	17.57	1.46	32.65	5.62	100	60.27
Shanghai	12.1	31.22	0.31	14.28	2.05	37.55	2.49	100	57.91
Guangzhou	21.95	23.46	1.35	9.91	3.6	35.57	4.16	100	56.67
Study area									
Liwan	12.3	26.99	1.13	19.41	3.1	32.77	4.3	100	59.83
Yuexiu	2.8	24.08	2.36	29.51	3.65	25.47	12.13	100	58.75
Haizhu	6.04	33.54	1.29	17.39	1.3	37.26	3.18	100	58.26
Tianhe	5.01	29.28	2.22	12.72	2.56	43.6	4.61	100	49.23
Baiyun	17.6	15.45	1.95	4.28	4.96	51.23	4.53	100	39.28
Huangpu	13.24	12.56	0.27	10.27	4.06	57.51	2.09	100	36.34
Luogang	34.43	8.21	2.37	0.38	5	44.89	4.72	100	45.39
Total	10.95	23.49	1.72	13.56	3.35	41.90	5.03	100	49.72

(2) Changes in home ownership rate

Because the type of "other housing" cannot be distinguished into rental or purchased housing, the calculation of home ownership rate ignores the impact of other housing. That is to say, the home ownership rate in 2000 and 2010 is total percentage of self-built housing, purchased commodity housing, purchased economical and suitable housing, and purchased original social housing. This reveals that the home ownership rate in Guangzhou decreased from 62.31% in 2000 to 49.72% in 2010, indicating that the contribution rates of various housing tenures to the home ownership rates were significantly varied. The total contribution rate of purchased original social housing and economical and suitable housing was 34.05%, but that of purchased commodity housing was only 7.96% in 2000, which was basically the start of full housing marketization system reform in China. This result shows that the enhancement of the home ownership rate was mainly due to the housing reform of public housing, and during this phase, purchased original social housing played an important role in increasing such a rate. In 2010, the total percentage of purchased original social housing and economical and suitable housing was only 15.29%, which was 18.76% lower than that in 2000. In contrast, the percentage of purchased commodity housing was increased from 7.96% in 2000 to 19.16% in 2010.

Based on these statistics, the contribution to the home ownership rate, incurred from the housing market distribution force, was enhanced, and the effects of redistributing forces were reduced greatly. Much purchased original social housing was sold and changed into purchased second-hand housing. In addition, influenced by the renovation of the central cities and large-scale expansion of urban construction to the rural outskirts, numerous urban villages (*cheng zhong cun*) and self-built housing areas were demolished; the percentage of self-built housing was reduced from 20.30% in 2000 to 10.95% in 2010. This occurrence substantially reduced the home ownership rate. The comparative results also demonstrate

that, influenced by the increasing housing prices, the percentage of rental commodity housing was greatly increased from 14.39% in 2000 to 41.90% in 2010 (rental other housing), resulting from the decreased purchasing power of urban residents because of higher housing prices. Moreover, the results of the comparison imply that the proportion of social housing was lower when the enthusiasm of local governments in providing social housing was not high. In 2000 and 2010, the percentage of purchased economical and suitable housing in Guangzhou was 2.85% and 1.72%, respectively (the percentage of purchased economical and suitable housing was also only 5.05%, as indicated in the national sixth population census in 2010 (in the urban part), suggesting similar characteristics with Guangzhou), and the percentages of cheaper rental housing in 2000 and rental social housing in 2010 (nearly similar to that of cheaper rental housing in 2000) were only 17.13% and 3.35%, respectively, with significantly reduced proportions. Generally speaking, the proportion of affordable housing purchased in Chinese cities was low, which deviates from the original intention of China's urban housing system reform to a certain extent, indicating that China's urban housing supply has been excessively market oriented. The home ownership rate in the study area is basically close to that in Beijing and Shanghai, reflecting the similar characteristics of China's big cities; that is, marketization has played a basic role in improving the home ownership rate.

4.2. Spatial Patterns of Different Forms of Housing Tenure

(1) Self-built housing. Constructed by the villagers themselves, self-built housing is mainly distributed in rural areas. The regions with a higher degree of agglomeration in the two years are primarily dispersed in peripheral towns. Urban villages in the central city belong to the typical rural areas surrounded by urban construction areas, and self-built housing accounts for the majority of the settlements in urban villages. In this case, the villages within the central city are also the main agglomeration areas of self-built housing (Figure 3). Compared with 2000, with the rapid development of urbanization and the expansion of urban scale, a large amount of rural land was transformed into urban construction land in 2010, and the high concentration area of self-built housing in the suburbs was gradually reduced. Moreover, urban renewal and demolition of parts of villages reduced the self-built housing scope, with a higher agglomeration degree within the central cities and only scattering in Fangcun and Haizhu districts. Furthermore, the LQ index of self-built housing for each street (or town) was reduced to different degrees in 2010, thereby evidently decreasing the entire agglomeration degree.

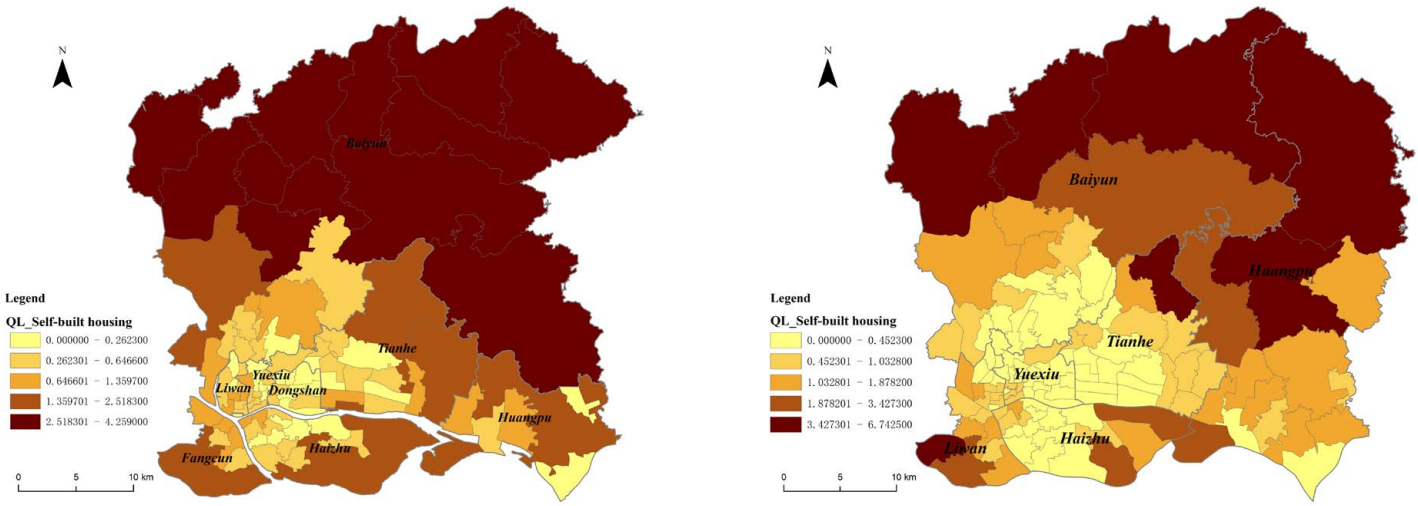

Figure 3. Location quotients for self-built housing in 2000 (**left**) and 2010 (**right**).

(2) Purchased commodity housing. Purchased second-hand housing was separated from purchased commodity housing in the 6th census. These two housing categories were

combined as purchased commodity housing (including second-hand housing) aiming to compare with the 5th census in the current study. Agglomeration distribution of purchased commodity housing was closely related to commodity housing development and secondary housing market transactions (Figure 4). In 2000, areas with a high agglomeration distribution of purchased commodity housing were mainly distributed in the Central-eastern Tianhe District, Northern Haizhu District, Southern Baiyun District, and Xiagang Street in the Huangpu District, which were all considered hot spots of commodity housing development. The agglomeration degree of purchased commodity housing was relatively low on the outskirts of town. Meanwhile, the areas with higher proportions of purchased commodity housing in 2010 were mainly located in the central city and its outer edge, primarily including the central and western parts of the Tianhe District, North-western Haizhu District, and Central-southern Baiyun District and exhibited different characteristics from that of 2000. One was that the proportion of purchased commodity housing on each street (town) was generally higher than that in 2000, and scopes with a higher agglomeration degree became wider. The other was that with the acceleration of the urban renewal process in central cities, cheaper rental housing was displaced by development and construction of commodity housing. Accordingly, areas with a higher proportion of cheaper rental housing in 2000 were gradually transformed into areas with a higher proportion of purchased commodity housing (including second-hand housing) in the central cities.

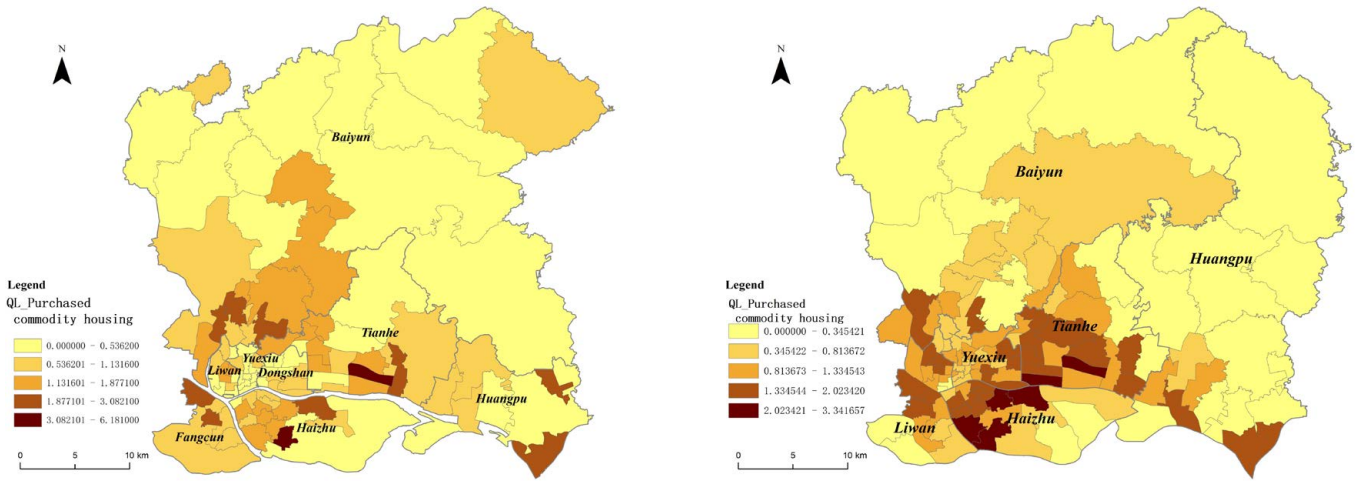

Figure 4. Location quotients for purchased commodity housing in 2000 (**left**) and 2010 (**right**).

(3) Purchased economical and suitable housing. The construction land of economical and suitable housing was allocated by the government, and construction was done by developers. In this case, the government provided the developers with compensation from the land price and tax, so the housing price was much lower than the market price. The government often selected the regions with low land prices as construction land for affordable housing to save construction costs. The spatial distribution features of purchased economical and suitable housing (Figure 5) in 2000 and 2010 were basically similar. In particular, areas with higher agglomeration proportion were scattered in the outer edges of the central city, while the Central-southern Baiyun District and parts of Tianhe and Luogang districts had relatively high proportions.

(4) Purchased original social housing (main reformed housing). With the relaxation of the policies for purchased social housing coming into the market, numerous original social housing properties came into the market and were transformed into purchased second-hand housing. Moreover, Guangzhou completely stopped their welfare housing distribution after 2000, and new purchased social housing was no longer seen. These occurrences significantly decreased the proportion of purchased original social housing in 2010. The areas with a high proportion of purchased original social housing in 2000 were mainly distributed in the Dongshan District, Yuexiu District, and Western Tianhe District

(Wushan Street, Shipai Street, etc.) (Figure 6), in which party and government organizations and shiye enterprises were intensively located. In other words, a dense region of units existed with the distribution rights of purchased original social housing. Contrarily, the spatial agglomeration degree of purchased original social housing decreased in 2010. With the deepening of reform in the housing market, much social housing is expected to be demolished because of aging or to become second-hand housing via market exchange. Under such a condition, the degree of agglomeration and the proportion of purchased original social housing in most sub-districts or towns will be further reduced.

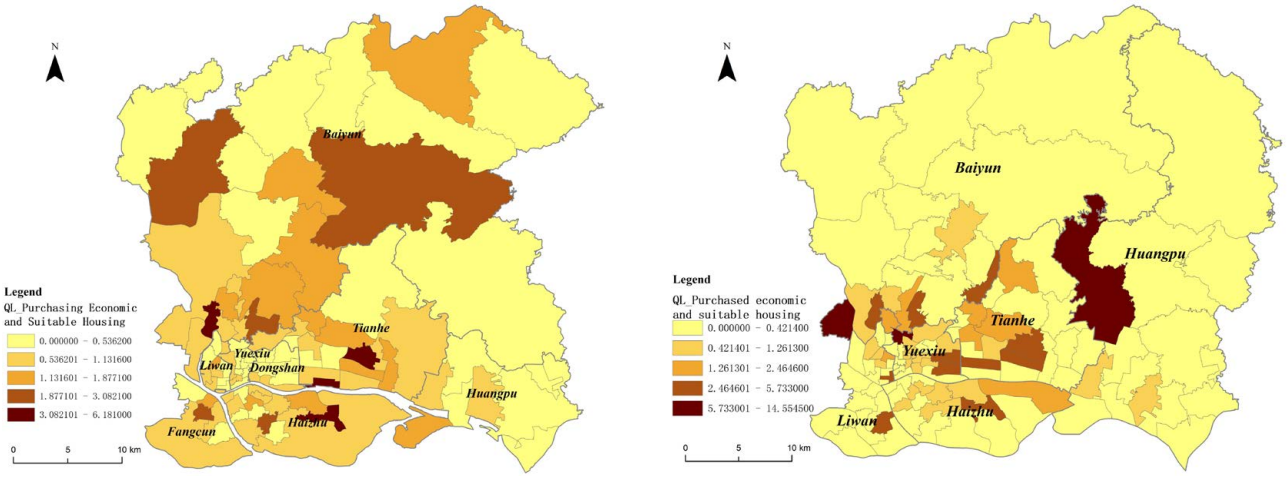

Figure 5. Location quotients for purchased economical and suitable housing in 2000 (**left**) and 2010 (**right**).

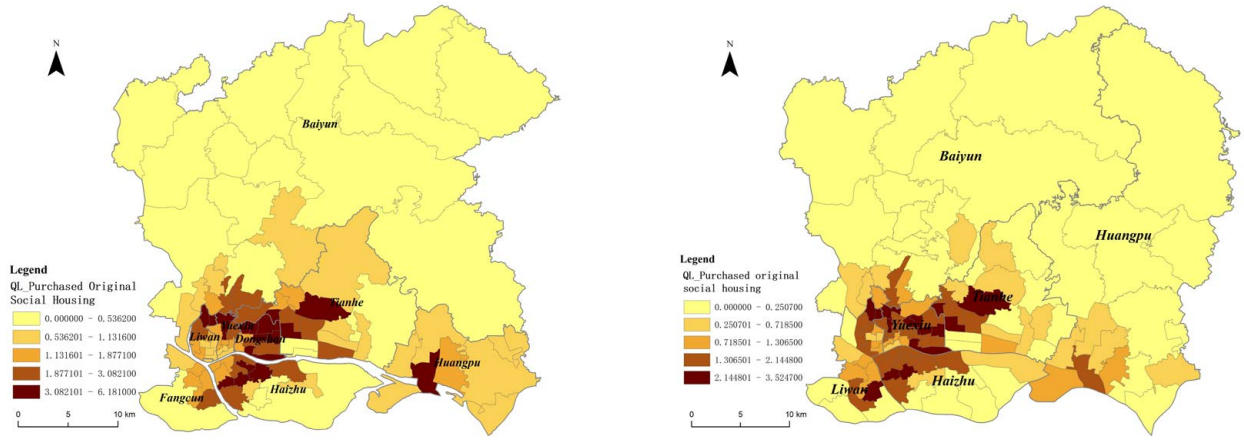

Figure 6. Location quotients for purchased original social housing in 2000 (**left**) and 2010 (**right**).

(5) Rental social housing (cheaper rental housing)**.** Rental social housing is mainly cheaper rental housing. In 2000, areas with a higher agglomeration of rental social housing were generally distributed in old cities, especially in the Yuexiu District and Liwan District (Figure 7). Compared with the situation in 2000, the spatial distribution difference of rental social housing in 2010 was greater; the areas with higher agglomeration were basically transferred to the suburbs, mostly in the Southern Baiyun District, Luogang District, and Northern Tianhe District. The primary reason for this was that before 2000, the local government provided the local low-income groups with cheaper rental housing largely by retrieving the original dormitories of work units in the socialist era. Therefore, the areas with a higher proportion of rental social housing were principally concentrated in the old cities. Meanwhile, after 2000, a great deal of cheaper rental housing in the old cities was demolished as a result of rapid and vigorous renewal. During this period, however,

the local government constructed a certain amount of cheaper rental housing in the outer suburbs to resettle the original tenants and reduce the land costs required for construction of new local low-income households, greatly enhancing the proportion of cheaper rental housing in the suburbs.

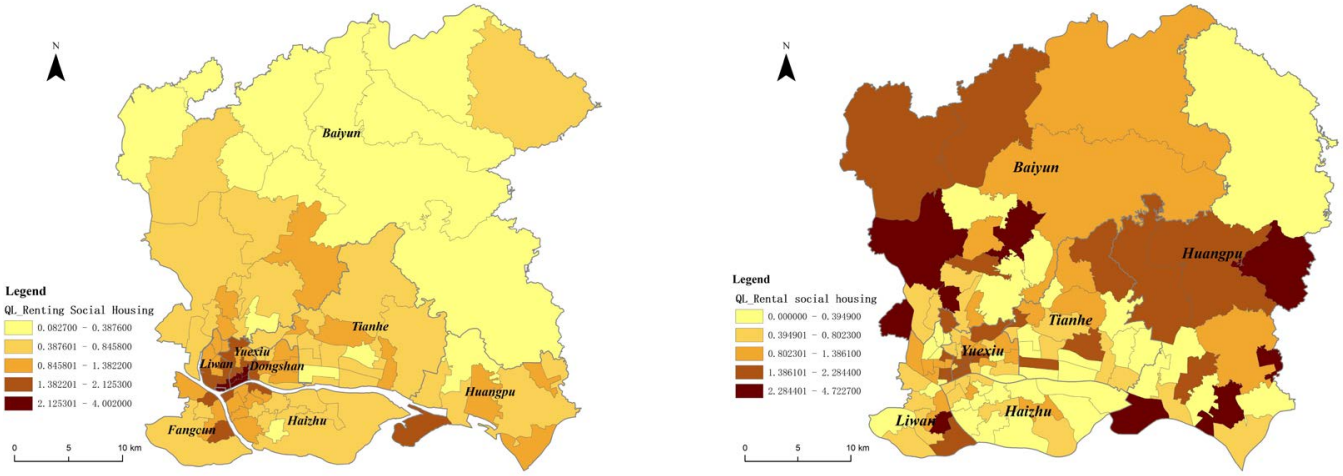

Figure 7. Location quotients for rental social housing in 2000 (**left**) and 2010 (**right**).

(6) Rental commodity housing. In general, areas with higher regional agglomeration of rental commodity housing for 2000 and 2010 were distributed in suburban areas (Figure 8). In particular, the proportion of rental commodity housing for major streets (or towns) in the outer edges of the central cities in 2000 was higher than 10%. As opposed to the case in 2000, the proportion of rental commodity housing substantially increased in 2010 and was extensively affected by the increase of housing prices. During this year, the areas with a higher proportion of rental commodity housing gradually expanded to the periphery, and higher agglomeration areas were observed in South-central Baiyun District, most parts of the Huangpu District, and Southern Haizhu District.

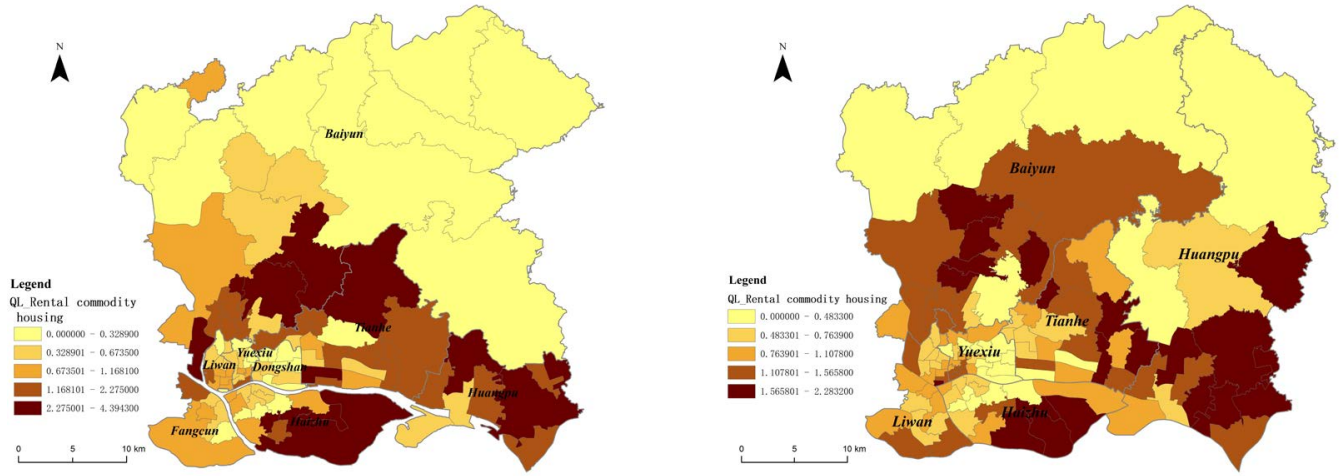

Figure 8. Location quotients for rental commodity housing in 2000 (**left**) and 2010 (**right**).

4.3. Tenure-Based Residential Segregation

The above research on tenure-based spatial patterns reflects the evident tenure-based residential differentiation in Guangzhou. Based on this, two typical dimensions (evenness and centralization) were selected to measure tenure-based residential segregation of Guangzhou from multiple perspectives (one group and two groups). The majority of segregation indexes for the two groups are classified into rental social housing, purchased social housing, rental open-market housing, and purchased open-market housing, in terms

of housing tenure and housing provision sectors. Social housing mainly refers to welfare housing supplied by the local government or work units, and open-market housing is rented or purchased via the market. The central coordinates for the centralization index reflect the spatial relationship between tenure-based housing spatial agglomeration and the urban center (the urban center in two years is set as the center point of Linhe Street in the Tianhe District). The analysis results are shown in Tables 3 and 4.

Table 3. Measures of socio-spatial segregation in 2000 and 2010 (one group).

Types	2000		2010	
	IS	ACE	IS	ACE
Self-built housing	0.58	0.09	0.49	0.21
Purchased commodity housing	0.36	0.62	0.35	0.70
Purchased second-hand housing			0.32	0.71
Purchased economical and suitable housing	0.40	0.62	0.60	0.72
Purchased original social housing	0.44	0.73	0.48	0.75
Rental cheaper housing	0.33	0.64	0.36	0.50
Rental other housing	0.42	0.60	0.36	0.54

As demonstrated in Table 3, in 2000, self-built housing had the highest IS (0.58), followed by the purchased original social housing (0.44) and cheaper rental housing (0.33). Self-built housing was mainly distributed in urban rural areas in the urban periphery with relatively higher segregation. In 2010, the highest IS was transformed into purchased economical and suitable housing (0.60), followed by self-built housing (0.49). Compared with commodity housing, social housing had relatively higher segregation in the two years. The segregation of purchased economical and suitable housing and cheaper rental housing considerably increased in 2010 when compared with 2000. It has been reported in other research that purchased commodity housing had higher segregation in Shanghai because of the strengthened selectivity in commodity housing areas [11]. However, Guangzhou showed different characteristics from Shanghai: social housing (especially purchased economical and suitable housing and cheaper rental housing) had relatively higher segregation because of the local government's preference for suburbs with cheaper land prices to reduce construction costs. Moreover, with the expansion of purchased economical and suitable housing and cheaper rental housing construction scale in outer suburban areas, it was expected that a cluster of areas with large scale agglomeration of local low-income families would be formed, which would further strengthen the double marginalization of local low-income residents in society and space. For the ACE index, self-built housing was generally located in rural areas in the urban fringes, and hence it had a relatively lower ACE index in the two years. In 2000, apart from self-built housing, the ACE index for other housing types was above 0.6, in which the highest was purchased original social houses (0.73), followed by cheaper rental housing (0.64). Overall, original social housing (mainly reformed housing) concentrated in the central city was sold to tenants during the housing reform period, with the highest ACE index. Before 2000, cheaper rental housing was primarily situated in the central city and thus has a relatively higher ACE index. After much cheaper rental housing was demolished with the acceleration of urban renewal and gentrification processes in central cities, the ACE index for cheaper rental housing fell from 0.64 in 2000 to 0.50 in 2010.

Table 4. Measures of social-spatial segregation in 2000 and 2010 (two groups).

Variables		2000		2010	
X Group (Minority)	**Y Group (Majority)**	**ID**	**RCE**	**ID**	**RCE**
Self-built housing	Rental social housing	0.59	−0.54	0.48	−0.36
Purchased commodity housing		0.45	0.03	0.47	0.27
Purchased second-hand housing				0.47	0.30
Purchased economical and suitable housing		0.49	0.00	0.59	0.28
Purchased original social housing		0.32	0.20	0.56	0.36
Rental social housing					
Rental commodity housing		0.48	−0.03	0.36	0.02
Self-built housing	Purchased social housing	0.65	−0.64	0.66	−0.69
Purchased commodity housing		0.39	−0.15	0.37	−0.10
Purchased second-hand housing				0.26	−0.06
Purchased economical and suitable housing		0.47	−0.17	0.55	−0.08
Purchased original social housing		0.04	0.02	0.06	0.01
Rental social housing		0.30	−0.18	0.52	−0.36
Rental commodity housing		0.49	−0.20	0.51	−0.36
Self-built housing	Rental open-market housing	0.53	−0.51	0.43	−0.40
Purchased commodity housing		0.38	0.04	0.42	0.26
Purchased second-hand housing				0.45	0.30
Purchased economical and suitable housing		0.45	0.03	0.64	0.28
Purchased original social housing		0.52	0.21	0.54	0.37
Rental social housing		0.48	0.03	0.36	−0.02
Self-built housing	Purchased open-market housing	0.16	−0.14	0.41	−0.41
Purchased commodity housing		0.44	0.39	0.21	0.21
Purchased second-hand housing				0.30	0.23
Purchased economical and suitable housing		0.44	0.38	0.61	0.22
Purchased original social housing		0.58	0.52	0.43	0.30
Rental social housing		0.51	0.39	0.38	−0.06
Rental commodity housing		0.42	0.36	0.34	−0.04
Own	Rent	0.28	−0.08	0.36	0.15
Rent	Own	0.28	0.08	0.36	−0.15
Social housing	Open-market housing	0.48	0.37	0.39	0.27
Open-market housing	Social housing	0.48	−0.37	0.39	−0.27

For the ID index for two groups (see Table 4), purchased commodity housing, purchased economical and suitable housing, and purchased original social housing were identified to increase in different degrees from 2000 to 2010, and self-built housing and rental commodity housing underwent different degrees of decline, exhibiting patterns similar to those of the IS index for one group. The RCE index for two groups reflected the spatial agglomeration relationship between two social groups. The RCE index in Table 4 indicates the spatial relationship for different housing tenures and shows some characteristics, as follows. Firstly, self-built housing was gathered in the urban periphery, and the degree of spatial concentration declined to some extent since 2000. Secondly, it was more obvious that spatial agglomeration areas of cheaper rental housing were transferred from the central city to the suburban areas, and the RCE index declined. Finally, the gathering area of rental commodity housing was eventually intended to expand to suburban areas because tenants have to move to suburban areas to find affordable rental housing with the substantial increase in housing rental prices in the cities.

5. Conclusions and Discussion

The internal logic of housing resource distribution in Guangzhou was transformed from being a redistribution system into a market-oriented one from 2000 to 2010. This particular transformation has profoundly affected and restricted not only the access and opportunities of gaining urban housing resources, but also acquiring tenure-based residen-

tial segregation. Meanwhile, the urban construction lands extensively expanding into the suburbs, the urban renewal that triggered a massive "gentrification" process in the central city, and the large-scale development of real estate and rapidly rising housing prices have profoundly affected urban residential spatial restructuring and segregation. Since 2000, the home ownership rate has decreased, and the housing tenure structure has greatly changed with the increased market housing distribution in Guangzhou.

The percentage of purchased or rental commodity housing significantly increased, and the increasing of housing prices greatly influenced the housing purchasing power of residents, decreasing the home ownership rate from 62.31% in 2000 to 49.72% in 2010. The increase of home ownership prior to 2000 mainly benefited from the social housing reform policy during the phase of the housing system reform. Meanwhile, as one of the products of housing reform, purchased original social housing had a larger proportion, contributing to the home ownership rate. The extensive expansion of urban construction land into rural outskirts reduced the proportion of self-built housing in rural areas. In this case, the contribution of self-built housing to the growth of the home ownership rate decreased. The enthusiasm of local governments to provide social housing is not high, and the percentage of purchased economical and suitable housing decreased from 2.85% in 2000 to 1.72% in 2010. Such an occurrence limited the possibility of increasing home ownership and largely deviated from the original intention of the reform of the urban housing system in China. After 2000, with the relaxing of restriction policies for reformed housing to be sold, much reformed housing was sold and became second-hand housing, significantly reducing the proportion of purchased social housing. Restricted by the thresholds of affordable housing and building scale, the proportion of purchased economical and suitable housing or cheaper rental housing was still relatively low. In this event, the majority of low-income families could seek shelter only through the market. Nevertheless, under the control of high prices, these families could only rent commodity housing, which substantially increased the proportion of rental commodity housing in 2010. Improving housing provision is difficult for local government, and contradictions in China's affordable housing policy and intergovernmental structures have become the main barriers for affordable housing provision [18].

In 2010, the sum proportion of affordable housing (including cheaper rental housing and purchased economical and suitable housing) in Guangzhou was only 5.07%, much lower than that of Hong Kong and Singapore. This original goal of this national housing system reform in 1998 was more in accordance with actual urban China. However, because the housing supply over-emphasized housing marketization, and local governments have not implemented sufficient undertakings to provide affordable housing construction, affordable housing construction cannot satisfy the demands of low-income families; thus, the housing supply system still lacks economical and suitable housing. Therefore, local governments should vigorously strengthen the construction of affordable housing, relax their accessibility standards, and expand the coverage of groups qualifying for social housing. Local governments often add the "threshold" of "requires a local household registration" for accessibility standards for social housing, and migrants are frequently excluded from the social housing provision system granted by local governments. Migrants have no choice but to rent a house with a market price. To search for a relatively cheaper house, migrants continuously move to outer suburban areas, because housing (including rental) prices have significantly increased in city centers since 2006.

Tenure-based spatial patterns have experienced a large scale of spatial restructuring since 2000. With accelerated urban renewal of the city and gentrification processes, many low-income communities have been demolished and displaced by new high-income commodity communities. Tenure-based spatial patterns in the central city changed it from being an area with a high agglomeration of cheaper rental housing to an area with a high agglomeration of purchased commodity housing. Local governments often prefer to construct a certain scale of affordable housing in the outer suburbs to resettle urban low-income families and save development costs. Influenced by the large-scale expansion

of urban construction land into suburbs, the areas with a higher proportion of self-built housing were largely reduced in 2010. At present, the regions with a higher proportion of rental commodity housing are increasing, as influenced by high prices and high rents.

Other studies specify that an ID below 0.3 indicates a low extent of residential segregation, an ID between 0.3 and 0.6 implies a moderate extent of segregation, and an ID above 0.6 demonstrates a high extent of segregation (for details, see [52]). Based on this range, all types of housing tenure in Guangzhou basically have a moderate extent of segregation for 2000 and 2010. The ID index of purchasing affordable housing was 0.60 in 2010, close to the residential segregation index (0.6) between African Americans and Caucasians in the US in 2010, with a high extent of segregation; this must be given due attention by society [53].

It is necessary to be aware of the social and spatial double marginalization of residents in affordable housing communities. Local governments prefer suburbs with relatively low land rent and construction sites of certain scales of economical and suitable housing or cheaper rental housing for resettling local low-income groups or households to save land development costs. The analytical results of this research reveal that the distribution of purchased economical and suitable housing and cheaper rental housing had higher segregation in 2000 and 2010. Constructing certain scales of affordable housing in the urban fringe or suburban areas can solve the housing problems of local low-income families in the short term, but will lead to inadequate employment opportunities, excessive separation between work and home, and travel difficulties for low-income families. Moreover, such a condition may even aggravate the poverty status of these low-income families and cause social and spatial double marginalization for residents in affordable housing communities, because of the remote location, inadequate service infrastructure, poor construction standards, and insufficient space and other opportunities for affordable housing communities in suburban areas. Therefore, the site selection of affordable housing should be properly dispersed and balanced, avoiding suburban-oriented tendencies. The mixed community building must also be strengthened, the basic living conditions of the locals must be improved, and the accessibility to spatial opportunities for affordable housing communities must be enhanced.

The possible contribution of this paper taking Guangzhou as an example is to analyze the situation and internal mechanism of tenure-based residential segregation in China's big cities under the background that the market has acted as the basic force for housing resource allocation after China completely abolished welfare housing distribution and entered the stage of rapid housing marketization. The limitations for this paper are as follows: (1) the 7th census in China has not yet been published, so we don't know the tenure-based residential segregation of China's big cities during the period of 2010 to 2020, during which there was also rapid development of housing marketization; (2) the paper only selects some key indicators of residential segregation measures, which affects the comprehensiveness of residential segregation analysis to some extent. In future research, it is necessary to add more indicators and include the data of the 7th census into the analysis, so as to comprehensively analyze the residential segregation in China's big cities after China's market-oriented housing reform.

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