

No Place in the City: The Segregation of Affordable Formal Private Rentals in Beijing

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Residential segregation by income has become an emerging concern in Chinese cities. Existing literature on residential segregation has mostly focused on the informal rental market, and little is known about the formal private rentals. Nevertheless, with the continued removal of informal settlements, formal private rentals are likely to play a more pivotal role in the provision of affordable housing in the upcoming years. Using data from online rental listings, this paper examines changes in the spatial distribution of affordable formal private rentals in Beijing between 2015 and 2018. Our study finds that the availability of affordable formal private rentals decreased drastically in the central city area in the three-year period, whereas the remaining affordable units in the central-city subdistricts became increasingly segregated from other higher-priced rentals. When compared across rentals of different price ranges, the affordable rentals ended up being the most segregated in both 2015 and 2018, with a city-level index of dissimilarity of 0.71 and 0.75 respectively. The research findings necessitate policies that promote affordable rental provision in central locations.

Keywords: residential segregation; housing affordability; formal private rental; Beijing

1 Introduction

Residential segregation by income has become a pressing issue in Chinese cities. The series of economic reforms in the 1980s and '90s not only increased the average income of Chinese families but also widened the wealth gap between rich and poor (Harvey, 2007, p. 17; Wang, 2016, p. 168). After the establishment of land and housing markets in the 1990s, wealth inequality started to manifest itself in the sorting of rich and poor into different neighborhoods (Li & Wu, 2008; Wu, 2002).

The degree of residential segregation in Chinese cities can be greatly affected by the spatial configuration of affordable rentals. Even though China has one of the highest homeownership rates in the world (Zeng et al., 2020), there are still over one-third of the population living in rental housing in megacities like Beijing and Shanghai (National Bureau of Statistics of China, 2012). The proportion of renters in the lower-income population tends

to be higher than the city's average. According to the 2017 China Migrants Dynamic Survey, about 62% of migrants¹----a group that is overrepresented among Beijing's lower-income population (Shi et al., 2017) ----lived in rental housing.

Rental units in Chinese cities, as elsewhere, can be characterized as formal or informal based on the legality of their contracts. Informal rentals tend to have lower prices than the formal rentals at similar locations because of the insecurity of tenure and the relatively deteriorated living conditions. Formal rentals, both private and publicly-subsidized, are usually not the first choice of residence for lower-income renters (Huang & Tao, 2015; Kim, 2016; Kroeber, 2016, pp. 76–79). Lower-income renters often end up living in very small, poor-quality housing in the informal sector, which includes illegal rental units in urban villages² (*cheng zhong cun*) (Huang & Tao, 2015; Wang, 2016; Wang et al., 2009; Wu, 2002; Zheng et al., 2009), group rentals³ (*qun zu fang*) (Harten & Kim, 2018), and basement rentals (Huang & Yi, 2015; Kim, 2016; Yu & Cai, 2013). Existing evidence suggests that the informal sector plays a vital role in the provision of affordable housing for lower-income people.

Nevertheless, the informal rental stock has been declining due to a series of redevelopment programs in recent years (Li & Kong, 2019; Lin et al., 2014; Liu & Wong, 2018). With the decreasing stock of informal rentals, private rentals in the formal market are likely to play a more pivotal role in the provision of affordable housing for the lower-income population. The availability of affordable rentals affects people's health and well-being, and also their employment and educational opportunities (Byrne & Diamond, 2007; Fan et al., 2014). It is, therefore, important to find out how the spatial distribution of affordable rentals in the formal market has changed in recent years.

Existing research on the segregation of affordable rentals in Chinese cities has mostly focused on the informal sector (Harten & Kim, 2018; Huang & Yi, 2015; Kim, 2016; Y. P.

Wang et al., 2009; Wu, 2002; Yu & Cai, 2013; Zheng et al., 2009). Few studies have investigated the spatial configuration of the affordable rentals in the formal market and how it has changed over time. This paper pays attention to the formal private rentals in Beijing, examining their spatial distribution between 2015 and 2018 using data collected from online real estate brokerages.

The article begins with a discussion of the existing literature on the segregation of affordable rentals in Beijing. Next, the study area and data used for this study is described. In the third section, the methods used in the analysis are discussed. Section four presents the findings on the spatial configuration of affordable formal private rentals. Finally, in the conclusion, the policy implications of the findings are discussed.

2 The segregation of affordable rentals in Beijing

The emergence of residential segregation

Urban residences in Beijing were almost homogeneous before the economic reform. In the previous planned economy, the central and local governments were in charge of housing production and allocation. Urban residents paid a nominal rent to live in the state-allocated public housing (Kroeber, 2016, pp. 76–79; Wang, 2016, pp. 143–144), which was designed and constructed in a uniform way to emphasize egalitarianism and collectivism (Wang, 2016, p. 148).

In the 1990s, the central government restructured the previous in-kind welfare housing system into a market-oriented one (Lee & Zhu, 2006; Wu, 2015). The state gradually retreated from the direct provision of public housing, and the market started to play a major role in the provision of housing. In a market-oriented economy, people's income directly affects the types of housing they can afford. Clustered 'zones of affluence' and gated communities targeting the rich began to spring up in Beijing (Hu & Kaplan, 2001;

Wu, 2005; Wu & Webber, 2004), while urban villages where low-wage migrants concentrated were found in the urban periphery (Gu, 2001; Ma & Xiang, 1998). The disparities between the living conditions of the urban affluent and the urban poor began to emerge.

Formal and informal rentals

Both formal and informal rentals exist in Beijing's housing market (Table 1). The former have the legal rights of occupancy while the latter do not. The informal rentals--including illegal rentals in urban villages, basement rentals, and group rentals--serve as the major housing source for the lower-income population (Wang, 2016, p. 170; Zhai et al., 2007). Regardless of their poor living conditions, the informal rentals typically have locational advantages; they enabled lower-income people to live close to job opportunities and sometimes gain better access to urban amenities (Harten & Kim, 2018; Huang & Yi, 2015; Kim, 2016; Knowles, 2016; Z. Li, 2010; Peng et al., 2010; Wang et al., 2009; Wu, 2002; Yu & Cai, 2013; Zheng et al., 2009). Nevertheless, the lower-income people who live in informal rentals are often found to be physically and/or socially⁴ segregated from other urban residents (Oreglia, 2009; Wang et al., 2009; Wu, 2002; Zheng et al., 2009). Dehumanizing names such as "ant tribe" and "mouse tribe" has been used to refer to tenants who live in informal rentals, perpetuating the social stigma associated with the lower-income group (Huang & Yi, 2015).

Formal rentals, which include public and private rentals, are often seen as secondary in providing affordable housing for the lower-income population. Public rental housing is designed and constructed following local housing regulations but has been criticized for its limited provision and distant locations from the city center (Kim, 2016; Lin et al., 2014). A recent study suggested that public rental housing also faced the problem of being physically isolated from other commercial housing (Chu et al., 2019). The affordable private rentals in

the formal market are rarely the focus of housing research in China due to its limited supply (Huang & Tao, 2015). Few studies have examined the spatial configurations of affordable formal private rentals in Chinese cities and how they change over time.

[Table 1 here]

The removal of informal settlements

The informal housing sector is seen as a major barrier to economic development and city branding in China (Lai et al., 2014; Tian, 2008; Zhu, 2019). To proclaim Beijing's image as a leading global city, the municipal government has taken a series of actions to improve the city's physical environment and boost its economic growth, in which the redevelopment of informal settlements plays a major role (Wong et al., 2018; Wong & Liu, 2017).

The municipal government's effort to redevelop the informal settlement can be traced back to the early 2000s (Hsing, 2012). In 2004, there were 343 identified urban villages in Beijing, of which 171 were torn down between 2005 and 2010 (Mu, 2004; Rao, 2011). In face of the 2008 global financialization crisis, the redevelopment of urban villages was promoted by the central government as a policy instrument to stimulate capital circulation and help cities to recover from their economic downturns (Chen, 2018; He et al., 2020).

More extensive demolition of the informal rental sector has been carried out by the municipal government in recent years. In the end of 2017, a fire broke out at a "warehouse-cum-apartment" in southern Beijing, which triggered a "sweeping inspection" of illegal rentals in the city (Liu, 2017; The Economist, 2017). The tragic fire provided a catalyst for the municipal government to enforce stricter regulations on the rental market and speed up the clearance of informal rentals (Gao, 2017).

Since the number of informal rentals has been decreasing (Huang & Yi, 2015; Liu & Wong, 2018; Mohabir et al., 2017; Wong et al., 2018; Wong & Liu, 2017) and the provision of public rentals is limited (Huang & Tao, 2015), the share of low-income renters who live in

formal market-rate rentals is likely to increase in the coming years. While there are numerous empirical studies on rentals in the informal market (Harten & Kim, 2018; Huang & Yi, 2015; Kim, 2016; Wang et al., 2009; Wu, 2002; Yu & Cai, 2013; Zheng et al., 2009) and on public rentals provided by the government (Huang & Tao, 2015; Lin et al., 2014), little is known about rentals in the formal market. This paper aims to fill this gap by asking the following questions: Has the stock of affordable formal rentals grown in recent years? How has the spatial distribution of affordable formal rentals changed in recent years? What can the municipal government do to enhance affordability for lower-income renters? We intend to answer these questions through the study of formal private rentals in Beijing.

3 Study area and data sources

The city of Beijing had a population of 21.7 million and a land area of 16,410 square kilometers as of 2015. The case study area includes twelve districts of the city with a population of 19.9 million, accounting for 93% of the total population (Figure 1). The twelve districts exercise control over 252 sub-districts (*jiedao/xiang/zhen*). Sub-districts are the finest geographic level reported in publicly accessible government statistical yearbooks. Six inner districts constitute the central city area--a densely populated area that has remained the focus of urban policy for decades. Seven new towns, as derivatives of Beijing's 2020 master plan, function as the economic sub-centers surrounding the central city area⁵. The northern and western mountainous part of the city has been designated as the ecological preservation area since 2005, where the preservation of natural resources is set as the first priority in local development agendas.

[Figure 1 here]

The Beijing municipal government publishes the average disposable incomes for households in the bottom 20%, 20th to 40th percentile, 40th to 60th percentile, and top 20% of the income distribution every year. In this study, we defined the lower-income population as

households in the bottom 40% of the income distribution. In 2015, the lower-income population had a larger average household size of 3.1 and a lower per-capita disposable income of 25,656 yuan (approximately 4,136 U.S. dollars in 2015) than the city's average (Table 2).

[Table 2 here]

Census surveys in China are conducted every ten years and often lag behind changes in the built environment. In contrast, data from the real estate brokerages can reflect immediate changes in the property market. This study takes advantage of data from the online rental listings to examine the spatial dynamics of affordable rentals in the formal market between 2015 and 2018.

We access the rental listings from Lianjia (<http://bj.lianjia.com>) and Woaiwojia (<https://bj.5i5j.com>), which are two major real estate brokerage firms in Beijing. In 2014, the two firms signed a pledge promising that all their rental units are legal and comply with the municipal regulations (Liu & Zhong, 2014), which, to a great extent, ensures the formality of the rental information they posted online. We employed a web-scraping software to collect rental listings every Sunday for a three-month period from January to March in 2015 and 2018. The information collected includes the apartment's geographical location, size (in square meters), and monthly rental price. From the original raw collections, we removed items that were duplicates, items that contained invalid or incomplete information, and items that were not about residential units but storage or commercial spaces. In the end, we obtained 68,733 items in 2015 and 48,925 items in 2018. Point of interest (POI)⁶ data in 2014 were also used in this study to compute the rentals' accessibility to public services and amenities.

4 Methods

Affordable rent

Defining the affordable rental price should take the socioeconomic status of urban residents, family size, number of dependent children, and other factors into account. But the limited availability of fine-grained demographic data constrained our ability to calculate a household-tailored affordable rent threshold. Western housing studies often use 30% of income as the upper limit of affordability, suggesting that families or individuals who spend more than 30 percent of their monthly income on housing as financially burdened (Leishman & Rowley, 2012; Schwartz & Wilson, 2008; Stone, 2010). The 30 percent of income measure has also been adopted by the U.S. Department of Housing and Urban Development as their standard for housing affordability (Schwartz & Wilson, 2008). While using a fixed ratio to measure housing affordability can be seen as arbitrary, it does provide a mathematically simple indicator that can be “compared across time and space (Stone, 2010, p.162).” To make our case comparable to studies in other countries, we define rents as affordable if they are lower than 30% of the average household disposable income.

We computed the monthly affordable rent threshold using the formula:

$$r = \frac{c}{a} \quad (1)$$

where r represents the upper limit of monthly affordable rent (yuan/m²); c denotes the maximum rent that a household could afford without causing affordability problems (defined as 30% of monthly disposable income); a is the minimum housing area standard (m² per capita) set by the municipal government in its public rental housing regulations (Beijing Municipal Commission of Housing and Urban-Rural Development, 2011).

Based on data from the Beijing statistical yearbook, the monthly disposable income was 2,138 yuan per capita in 2015, and 2,742 yuan per capita in 2018. The minimum

housing area was 15 m² per capita according to local regulations. Accordingly, the monthly affordable rent threshold was 42.76 yuan/m² in 2015, and 54.84 yuan/m² in 2018.

Measures of segregation

We measured the segregation of affordable rentals from two perspectives: the level of *concentration* of affordable rentals and the degree of *unevenness* of the distribution of affordable rentals. The density index (*DI*) and the proportion index (*PI*) were employed to capture the level of concentration:

$$DI_i = \frac{Df_i - Avg(Df)}{SD(Df)} \quad (2)$$

$$PI_i = \frac{Pf_i - Avg(Pf)}{SD(Pf)} \quad (3)$$

where DI_i refers to the standardized density of affordable rentals (number of units per km²) in sub-district i , and PI_i denotes the standardized proportion of the affordable rental stock to the total rental stock in sub-district i . If both $DI_i \geq 1$ and $PI_i \geq 1$, the subdistrict i will be categorized as having a high concentration of affordable rentals, both in terms of density and proportion. If $DI_i \geq 1$, and $PI_i < 1$, the subdistrict i will be categorized as having type I moderate concentration of affordable rentals, which indicates a high density but a relatively low proportion of affordable rentals. If $DI_i < 1$, and $PI_i \geq 1$, the subdistrict i will be categorized as having type II moderate concentration of affordable rentals, which indicates a high proportion but a relatively low density of affordable rentals. Otherwise, the subdistrict i will be categorized as having no concentration of the affordable rentals.

The index of dissimilarity (*ID*), the most widely used measure in the study of residential segregation (Allen et al., 2015; Krieger et al., 2017; Li & Wu, 2008; Mulekar et al., 2008), was employed to assess the level of the uneven distribution of affordable rentals. *ID* shows the proportion of affordable units that would have to relocate in order to achieve

an even distribution (Massey & Denton, 1988). ID ranges between 1 and 0. In our case, an ID equals to 1 indicates that the affordable rentals and the non-affordable rentals are completely isolated from each other, and an ID equals to 0 indicates that the two groups are intermingled evenly. To compute the ID for each subdistrict, we broke down the study area into multiple 1 km² rectangular cells using the Fishnet tool in ArcGIS. The formula for ID is:

$$ID = \frac{1}{2} \sum_{i=1}^N \left| \frac{b_i}{B} - \frac{w_i}{W} \right| \quad (4)$$

Where b_i represents the number of affordable rentals in a rectangular cell i ; B represents the number of affordable rentals in the sub-district that the rectangular cell affiliated to; w_i represents the number of non-affordable rentals in the rectangular cell i ; W represents the number of non-affordable rentals in the sub-district that the rectangular cell belongs to.

Researchers have come to a consensus after a considerable debate that an ID under 0.25 indicates little or no segregation, while an ID greater than 0.60 is interpreted as a high level of segregation (Gregory et al., 2011). Using these criteria, we categorize the sub-districts in our study as having low-, medium-, and high-levels of uneven distribution of affordable rentals. In a neighborhood with a high-level of uneven distribution of affordable rentals, over 60% percent of affordable rental residents have to move from the rectangular cell where the group is overrepresented to other cells to eliminate segregation.

5 The segregation of affordable rentals in the formal market

Shrinking affordable rental stock

The proportion of affordable rentals in our sample declined between 2015 and 2018. We identified 16,558 affordable units in 2015 and 5,230 affordable units in 2018, accounting for 24.09% and 10.69% of the total rental units in each year. The percentage of the affordable

rental stock in the samples shrunk more than one half between 2015 and 2018, indicating a greater difficulty for lower-income renters to find a place to live without causing affordability issues.

Rental prices in the study area increased drastically in the three years (Figure 2). The percentage of rectangular cells with median rent no less than 100 yuan/m² grew from 6.77% to 32.05% between 2015 and 2018. In contrast to the flourishing formal rental market, people's income rose at a much slower pace. While the average rent (yuan per m²) in our samples increased by 45.55% in three years, the city's average disposable income only increased by 28.69%. Several empirical studies have suggested that the demolition and redevelopment of informal settlements in Chinese cities have contributed to increasing housing prices through the improvement of physical environment and urban infrastructures (Chen & Jim, 2010; Hu et al., 2014; Huang, 2012; Zheng & Kahn, 2013; Zou & Chau, 2015). The loss of affordable housing that occurs in the redevelopment of informal settlements puts greater pressure on the remaining housing stock, contributing to higher rents throughout the market.

[Figure 2 here]

The concentration of affordable rentals decreased in the central city area between 2015 and 2018 (Figure 3). In 2015, 26.37% of the affordable rentals were located in the central city area. The proportion dropped down to 12.18% in 2018. The number of sub-districts in the central city area with moderate-to-high levels of concentration decreased from 17 to 5 in the three-year period. At the same time, subdistricts of concentrated affordable rentals started to emerge in the suburb, especially in the new towns. Accompanied by the removal of informal rentals in the central city area, the decreasing number of affordable formal private rentals implies a forced relocation of the lower-income renters to the urban

periphery. The potential migration of lower-income tenants from central city to bedroom suburb may result in longer commuting times and a heavier burden on the transit system.

[Figure 3 here]

Uneven distribution of affordable rentals

As the number of affordable rentals in the central city area decreased in the three-year period, the remaining affordable rentals in the area had become more unevenly distributed within subdistricts (Figure 4). The proportion of sub-districts with a relatively even distribution of affordable rentals decreased from 31% to 11% in the central city area, while the percentage of sub-districts with highly uneven distribution of affordable rentals increased from 11% to 33%. This implies an intensified physical isolation of affordable formal private rentals from the other rentals in both the central locations and the suburbs. No matter where the low-income renters end up living in the city, their residences tend to be distanced from other higher priced rentals. The physical separation of affordable formal private rentals might again reinforce the social marginalization of the lower-income group, just as the informal settlements did.

[Figure 4 here]

Most segregated market-rate rentals

The intensified segregation of private rentals is not occurring across all price points in the market. We broke down the sample into 5 groups based on the rental price: Group I corresponds to the affordable rentals; Group II to V were created by splitting the rest of the sample into four equal-size clusters. City-level *ID* for each of these groups was computed and compared between 2015 and 2018.

As shown in Figure 5, the affordable rentals are the most segregated compared to groups of higher-priced rentals. The affordable rentals became more unevenly distributed

from 2015 to 2018 as its *ID* increased from 0.71 to 0.75. The results suggest that, on a city level, there is a consistent pattern of segregation of the affordable rentals and the integration of the others. Formal private rentals of other price ranges, even the ones of the highest price range, have *ID*s lower than 0.60 in both years. The spatial distribution of affordable rentals (Group I) became more isolated in the three-year period, whereas the spatial distribution of luxury rentals (Group V) became more mixed.

[Figure 5 here]

Poor access to public services and amenities

Proximity to public transit and other public services are essential to lower-income households due to their lack of car ownership (Li et al., 2010). However, abundant research in the western world indicates that public services and amenities are capitalized into the price of land and the housing atop of it, making the housing in proximity to those services and amenities relatively less affordable (Dawkins & Moeckel, 2016; Heyman & Sommervoll, 2019; Rosen, 1974). In China, there is also strong evidence showing that variations in housing prices can be explained by variations in the housing units' physical and locational attributes (Hu et al., 2014; Huang, 2012; Zheng & Kahn, 2013; Zou & Chau, 2015). Our analysis demonstrates a pattern consistent with previous studies: the affordable rentals in the private market have poor access to public services and amenities compared to other higher-priced rentals (Table 3).

We use the POI data in 2014 to compute the average distance to the nearest subway station and the average number of restaurants, elementary schools, and medical services within a one-kilometer radius (10-minute walking distance) for the five rental groups in 2015. Among these groups, the affordable rentals have the longest average distance from the nearest subway stop, the least average number of restaurants, elementary schools, and medical services within a one-kilometer radius.

For low-income renters who are taking on or looking for entry-level jobs, proximity to public transit can increase the number of accessible jobs and reduce their daily commuting time. Before the massive city-wide clearance of informal settlement, low-income workers can gain access to public transportation and urban amenities by residing in informal rentals. However, the stringent regulation on the informal sector had made the informal rental less an option for the low-income workers. If the municipality continues to uproot the informal sector without supplementary initiatives to improve housing affordability, the lower-income tenants are likely to end up in isolated neighborhoods with poor public services.

[Table 3 here]

6 Discussion and Conclusion

With the continued removal of informal settlements, formal private rentals are going to play a more important role in the provision of affordable housing for lower-income population. This paper examines the change in the spatial distribution of the formal private rentals in Beijing between 2015 and 2018, using data collected from online rental listings. On a subdistrict-level, we measure the segregation of affordable rentals by the extent to which they are concentrated and unevenly distributed. On a city-level, we compare the affordable rentals with higher-priced rentals by the index of dissimilarity and their access to urban amenities. Our study finds that: (1) the affordable formal private rentals in the central city area not only shrank in number in the three-year period, but also became more isolated from other higher-priced rentals; (2) when compared across different price ranges, the affordable rentals ended up being the most segregated in both 2015 and 2018, with a city-level index of dissimilarity of 0.71 and 0.75 respectively; (3) consistent with the existing literature, the affordable rentals tend to locate in places with poor access to public services and amenities. Overall, it has become increasingly difficult for lower-income households to find a place to live in the city.

Decreasing housing affordability has long been a challenge for the low-income renters in Beijing (Gu, 2001; Zheng et al., 2009; Huang & Yi, 2015). As the national capital, Beijing has gone through rapid population growth in the past three decades. Between 1990 and 2018, Beijing's population increased from 10.86 million to 21.54 million⁷. The land and housing reforms in the 1990s, followed by a booming demand for housing, greatly drove up housing prices in the city. While the municipal government implemented a series of affordable housing policies, most of the benefits were distributed to middle-to-high-income households and homeowners (Huang, 2012; Hsing, 2012). Between 2012 and 2018, the accumulated government investment in public rental housing was 64 billion yuan—only one-sixth of the amount of money that the municipal government had put in the resettlement housing for displaced homeowners (Beijing Municipal Commission of Housing and Urban-Rural Development, 2019). By uprooting the informal sector without considering low-income people's housing needs, the municipal government is implicitly depriving their rights to live in the central city area.

The informal sector exists for a reason. Even with poor physical conditions, an informal rental close to public transit or workplace can be of great use value to a low-income worker. It is the low-income people's demand for affordable housing at central locations that created the informal sector in the first place. Researchers from different countries have demonstrated that the interconnection between the formal and informal sectors exists in the labor markets, financial markets, and housing markets (Burgers, 1998; Ayyagari et al., 2010; Ananya, 2005; Williams, 2008). The demolition of the informal settlement without sufficient provision of affordable housing sacrifices the livelihood of the poor tenants for the city's pursuit of economic growth.

There is a clear need for policies that focus on providing affordable housing for the lower-income population, especially in central locations. There are currently two affordable

housing programs in Beijing that aim to address the housing needs of low-income renters. One is the underfunded public rental housing program mentioned above, and the other is a rental subsidy program initiated in 2015 (Beijing Municipal Commission of Housing and Urban-Rural Development, 2015). The latter provides qualified households with monthly subsidies to rent housing on the formal market. While the program makes it possible for the lower-income population to rent market-rate housing with better access to public transit and employment, it is only open to individuals with local household registration. Yet, a well-designed rental subsidy program should take into account the housing needs of both local residents and migrants. To enhance the housing affordability of the low-income population as a whole, increased investment in public rental housing and broader implementation of the rental subsidy program are both essential.

It is important to note some limitations of this research. First, even though the two real estate brokerages promised to make sure that all their rental units are legal, there is still the possibility of imperfect implementation where informal units get into their listings. Second, the rentals in our dataset were still on the market on the collection date, which means that they had not yet been rented. Thus, the data demonstrate a near-future residential pattern instead of an existing one. Third, our sample only represents rental units listed through real estate brokerages, and it misses out units that are never publicly advertised and are instead rented through personal networks. More analysis is thus valuable to move beyond the online listings and explore formal private rentals rented through other channels. Nevertheless, our analysis sheds light on the increasing segregation of affordable formal private rentals in Chinese cities.

Notes

1. Migrants refer to people without local household registration (*hukou*) in the city where they live.
2. The distinction between formal and informal is a contractual one and not a structure-type one. The formal/informal divide can and does occur within urban villages.
3. Group rentals (*qun zu fang*) are private rental units that have been illegally converted to overcrowded dormitories.
4. Huang & Yi (2015) found that tenants who lived in basement rentals are socially segregated from the residents who live above ground. Oreglia (2009) found that low-income migrant women who lived in urban neighborhoods rarely interact with their urban neighbors.
5. The seven new towns, except Yizhuang, are pre-existing seats of the district governments. Yizhuang is a state-level economic and technological development zone that was established in 1992.
6. A point of interest (POI for short) is commonly used in cartography to represent a particular feature using an icon that occupies a particular geographical point (e.g. a restaurant, a shopping mall, or a hospital).
7. Beijing's population decreased between 2016 and 2018 due to the municipal government's efforts to control population growth, especially in the central city area. See Wong et al. (2018) for details.

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References

- Allen, R., Burgess, S., Davidson, R., & Windmeijer, F. (2015). More reliable inference for the dissimilarity index of segregation. *The Econometrics Journal*, 18 (1), 40-66.
- Ananya Roy. (2005). Urban Informality: Toward an Epistemology of Planning. *Journal of the American Planning Association*, 71(2), 147–158.
<https://doi.org/10.1080/01944360508976689>
- Ayyagari, M., Demirgüç-Kunt, A., & Maksimovic, V. (2010). Formal versus informal finance: Evidence from China. *The Review of Financial Studies*, 23(8), 3048-3097.
- Beijing Municipal Commission of Housing and Urban-Rural Development. (2011). *Beijingshi gonggong zulin zhufang shenqing shenhe ji peizu guanli banfa [The application, verification, and allocation of public rental housing in Beijing]*.
<http://zjw.beijing.gov.cn/bjjs/xxgk/qtwj/fwglitz/353852/index.shtml>
- Beijing Municipal Commission of Housing and Urban-Rural Development. (2015, October 29). *Wo shi fabu shichang zufang butie xinzheng [The municipal government launched a new rental subsidy program]*.
<http://zjw.beijing.gov.cn/bjjs/xxgk/xwfb/317882/index.shtml>
- Beijing Municipal Commission of Housing and Urban-Rural Development. (2019, August 02). *Beijing zhufang he chengxiang jianshe fazhan baipishu [White Paper for Urban and Rural Development in Beijing]*. Retrieved September 8, 2020, from
<http://zjw.beijing.gov.cn/bjjs/xxgk/zwdt/53599902/index.shtml>
- Burgers, J. (1998). Formal determinants of informal arrangements: Housing and undocumented immigrants in Rotterdam. *Journal of Ethnic and Migration Studies*, 24(2), 295-312.
- Byrne, J. P., & Diamond, M. (2007). Affordable Housing, Land Tenure, and Urban Policy: The Matrix Revealed. *Fordham Urban Law Journal*, 34, 527.

[https://heinonline.org/HOL/Page?handle=hein.journals/frdurb34&id=539&div=&coll
ection=](https://heinonline.org/HOL/Page?handle=hein.journals/frdurb34&id=539&div=&collection=)

Chen, Y. (2018, August 16). China ploughs \$144 billion into shantytown redevelopment so far in 2018. *Reuters*. <https://www.reuters.com/article/us-china-economy-property-idUSKBN1L10WC>

Chu, C., Nomura, R., & Mori, S. (2019). Actual Conditions of Mixed Public–Private Planning for Housing Complexes in Beijing. *Sustainability*, *11*(8), 2409. <https://doi.org/10.3390/su11082409>

Fan, Y., Allen, R., & Sun, T. (2014). Spatial mismatch in Beijing, China: Implications of job accessibility for Chinese low-wage workers. *Habitat International*, *44*, 202–210. <https://doi.org/10.1016/j.habitatint.2014.06.002>

Gao, C. (2017, November 27). *Beijing: How Does a Tragic Fire Turn Into the Mass Eviction of Migrant Workers?* <https://thediplomat.com/2017/11/beijing-how-does-a-tragic-fire-turn-into-the-mass-eviction-of-migrant-workers/>

Gregory, D., Johnston, R., Pratt, G., Watts, M., & Whatmore, S. (2011). *The Dictionary of Human Geography*. John Wiley & Sons.

Gu, C. (2001). Social polarization and segregation in Beijing. *Chinese Geographical Science*, *11*(1), 17–26. https://idp.springer.com/authorize/casa?redirect_uri=https://link.springer.com/content/pdf/10.1007/s11769-001-0003-7.pdf&casa_token=1i56oj633pIAAAAA:KM24e4EsdhFyX62fw5NsVB5GcZXnZXAtbKKopSX12feTTPWbdYCtAfexjtrj2Jo8t8L0MTWk90TuYoVW

Harten, J. G., & Kim, A. M. (2018). The Price of Crowding: Modeling the Rental Market for Overcrowded Housing in Shanghai. *USC Lusk Center for Real Estate Research Brief*. https://lusk.usc.edu/sites/default/files/research_briefs/The%20Price%20of%20Crowd

ing.pdf

Harvey, D. (2007). *A Brief History of Neoliberalism*. Oxford University Press.

He, S., Zhang, M., & Wei, Z. (2020). The state project of crisis management: China's Shantytown Redevelopment Schemes under state-led financialization. *Environment and Planning A: Economy and Space*, 52(3), 632–653.

<https://doi.org/10.1177/0308518X19882427>

Heyman, A. V., & Sommervoll, D. E. (2019). House prices and relative location. *Cities*, 95, 102373. <https://doi.org/10.1016/j.cities.2019.06.004>

Hsing, Y. (2012). *The Great Urban Transformation: Politics of Land and Property in China* (1 edition). Oxford University Press.

Hu, H., Geertman, S., & Hooimeijer, P. (2014). Amenity value in post-industrial Chinese cities: The case of Nanjing. *Urban Geography*, 35(3), 420–439.

<https://doi.org/10.1080/02723638.2014.886419>

Huang, Y. (2012). Low-income Housing in Chinese Cities: Policies and Practices*. *The China Quarterly*, 212, 941–964. <https://doi.org/10.1017/S0305741012001270>

Hu, X., & Kaplan, D. H. (2001). THE EMERGENCE OF AFFLUENCE IN BEIJING: RESIDENTIAL SOCIAL STRATIFICATION IN CHINA'S CAPITAL CITY. *Urban Geography*, 22(1), 54–77. <https://doi.org/10.2747/0272-3638.22.1.54>

Huang, Y., & Tao, R. (2015). Housing migrants in Chinese cities: Current status and policy design. *Environment and Planning C: Government and Policy*, 33(3), 640–660.

<https://doi.org/10.1068/c12120>

Huang, Y., & Yi, C. (2015). Invisible migrant enclaves in Chinese cities: Underground living in Beijing, China. *Urban Studies*, 52(15), 2948–2973.

<https://doi.org/10.1177/0042098014564535>

Kim, A. M. (2016). The extreme primacy of location: Beijing's underground rental housing

- market. *Cities*, 52, 148–158. <https://doi.org/10.1016/j.cities.2015.11.027>
- Knowles, G. (2016, May 27). *Life for China's migrant workers: Dorm that looks like prison* [News]. South China Morning Post. <https://www.scmp.com/magazines/post-magazine/article/1955023/life-chinas-migrant-workers-dorm-looks-prison>
- Krieger, N., Feldman, J. M., Waterman, P. D., Chen, J. T., Coull, B. A., & Hemenway, D. (2017). Local Residential Segregation Matters: Stronger Association of Census Tract Compared to Conventional City-Level Measures with Fatal and Non-Fatal Assaults (Total and Firearm Related), Using the Index of Concentration at the Extremes (ICE) for Racial, Economic, and Racialized Economic Segregation, Massachusetts (US), 1995–2010. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, 94(2), 244–258. <https://doi.org/10.1007/s11524-016-0116-z>
- Kroeber, A. R. (2016). *China's Economy: What Everyone Needs to Know*®. Oxford University Press.
- Lai, Y., Peng, Y., Li, B., & Lin, Y. (2014). Industrial land development in urban villages in China: A property rights perspective. *Habitat International*, 41, 185–194. <https://doi.org/10.1016/j.habitatint.2013.08.004>
- Lee, J., & Zhu, Y. (2006). Urban governance, neoliberalism and housing reform in China. *The Pacific Review*, 19(1), 39–61. <https://doi.org/10.1080/09512740500417657>
- Li, B., & Kong, X. (2019, February 20). 2019 nian jiang jiandingbuyi zhua shujie shenru zhengzhi “dachengshibing” [Sticking to the spatial dispersion of non-capital functions and the fight against “urban diseases” in 2019] [News]. Xinhuanet. http://www.xinhuanet.com/local/2019-02/20/c_1124142366.htm
- Li, J., Walker, J. L., Srinivasan, S., & Anderson, W. P. (2010). Modeling Private Car Ownership in China: Investigation of Urban Form Impact Across Megacities. *Transportation Research Record*, 2193(1), 76–84. <https://doi.org/10.3141/2193-10>

- Li, Z. (2010). Housing Conditions and Housing Determinants of New Migrants in Chinese Cities. *Chinese Sociology & Anthropology*, 43(2), 70–89.
<https://doi.org/10.2753/CSA0009-4625430204>
- Li, Z., & Wu, F. (2008). Tenure-based residential segregation in post-reform Chinese cities: A case study of Shanghai. *Transactions of the Institute of British Geographers*, 33(3), 404–419. <https://doi.org/10.1111/j.1475-5661.2008.00304.x>
- Lin, Y., De Meulder, B., Cai, X., Hu, H., & Lai, Y. (2014). Linking social housing provision for rural migrants with the redevelopment of ‘villages in the city’: A case study of Beijing. *Cities*, 40, 111–119. <https://doi.org/10.1016/j.cities.2014.03.011>
- Liu, R., & Wong, T.-C. (2018). Urban village redevelopment in Beijing: The state-dominated formalization of informal housing. *Cities*, 72, 160–172.
<https://doi.org/10.1016/j.cities.2017.08.008>
- Liu, Y., & Zhong, Z. (2014, April 23). Qianshu guifan fangwu zulin fuwu shixiang chengnuo: Beijing muqian yi mopai 3.7 wanhu weifa qunzufang [Signing a pledge of conformity with market rental regulations: The Beijing municipal government has investigated 37,000 illegal group rentals]. *The Beijing News*.
http://epaper.bjnews.com.cn/html/2014-04/23/content_508088.htm?div=-1#fina
- Liu, Z. (2017, November 19). 19 killed as fire sweeps through Beijing housing block [News]. South China Morning Post.
<https://www.scmp.com/news/china/society/article/2120558/19-killed-fire-sweeps-through-beijing-accommodation-block>
- Ma, L. J. C., & Xiang, B. (1998). Native Place, Migration and the Emergence of Peasant Enclaves in Beijing. *The China Quarterly*, 155, 546–581. JSTOR.
<https://www.jstor.org/stable/655950>
- Massey, D. S., & Denton, N. A. (1988). The Dimensions of Residential Segregation. *Social*

- Forces*, 67, 281. <https://academic.oup.com/sf/article/67/2/281/2231999>
- Mohabir, N., Jiang, Y., & Ma, J. (2017). Chinese floating migrants: Rural-urban migrant labourers' intentions to stay or return. *Habitat International*, 60, 101–110. <https://doi.org/10.1016/j.habitatint.2016.12.008>
- Mu, Z. (2004, September 30). Beijing tackles enclaves of poverty. *China Daily*. http://www.chinadaily.com.cn/english/endy/2004-09/30/content_378880.htm
- Mulekar, M. S., Knutson, J. C., & Champanerkar, J. A. (2008). How useful are approximations to mean and variance of the index of dissimilarity? *Computational Statistics & Data Analysis*, 52(4), 2098–2109. <https://doi.org/10.1016/j.csda.2007.07.007>
- National Bureau of Statistics of China. (2012). *Tabulation on the 2010 Population Census of the People's Republic of China*. China Statistical Press. <http://www.stats.gov.cn/tjsj/pcsj/rkpc/6rp/indexch.htm>
- Oreglia, E. (2009). Creating community, rejecting community: Migrant women in Beijing. *The Journal of Community Informatics*, 5(6). <http://www.ci-journal.net/index.php/ciej/article/download/580/536?inline=1>
- Peng, Y., Chang, W., Zhou, H., Hu, H., & Liang, W. (2010). Factors associated with health-seeking behavior among migrant workers in Beijing, China. *BMC Health Services Research*, 10(1), 69. <https://doi.org/10.1186/1472-6963-10-69>
- Rao, P. (2011, November 5). Beijing 2015 nian qian ni xiaomie “Chengzhongcun”; Muqian haiyou baiyu ge [Beijing Plans to Eradicate All the ‘urban villages’ before 2015; Till Now There Remains One Hundred Villages Untouched]. *The Beijing News*. <https://house.qq.com/a/20111105/000006.htm>
- Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy*, 82(1), 34–55.

<https://doi.org/10.1086/260169>

Shi, Q., Liu, T., Musterd, S., & Cao, G. (2017). How social structure changes in Chinese global cities: Synthesizing globalization, migration and institutional factors in Beijing. *Cities*, 60, 156–165. <https://doi.org/10.1016/j.cities.2016.09.001>

Stone, M. E. (2006). What is housing affordability? The case for the residual income approach. *Housing Policy Debate*, 17(1), 151–184.

<https://doi.org/10.1080/10511482.2006.9521564>

The Economist. (2017, November 30). In Beijing, the rich and poor are shocked. *The Economist*. <https://www.economist.com/china/2017/11/30/in-beijing-the-rich-and-poor-are-shocked>

Tian, L. (2008). The Chengzhongcun Land Market in China: Boon or Bane? — A Perspective on Property Rights. *International Journal of Urban and Regional Research*, 32(2), 282–304. <https://doi.org/10.1111/j.1468-2427.2008.00787.x>

Wang, Y. (2016). *A Century of Change: Beijing's Urban Structure in the 20th Century*. Springer. <https://link.springer.com/content/pdf/10.1007%2F978-3-319-39633-0.pdf>

Wang, Y. P., Wang, Y., & Wu, J. (2009). Urbanization and Informal Development in China: Urban Villages in Shenzhen. *International Journal of Urban and Regional Research*, 33(4), 957–973. <https://doi.org/10.1111/j.1468-2427.2009.00891.x>

Williams, C. C. (2008). A critical evaluation of competing representations of the relationship between formal and informal work. *Community, Work and Family*, 11(1), 105–124.

Wong, C., Qiao, M., & Zheng, W. (2018). ‘Dispersing, regulating and upgrading’ urban villages in suburban Beijing. *Town Planning Review*, 89(6), 597–621.

<https://doi.org/10.3828/tpr.2018.41>

Wong, T.-C., & Liu, R. (2017). Developmental Urbanism, City Image Branding and the “Right to the City” in Transitional China. *Urban Policy and Research*, 35(2), 210–

223. <https://doi.org/10.1080/08111146.2015.1122587>
- Wu, F. (2002). Sociospatial Differentiation in Urban China: Evidence from Shanghai's Real Estate Markets. *Environment and Planning A: Economy and Space*, 34(9), 1591–1615. <https://doi.org/10.1068/a34196>
- Wu, F. (2005). Rediscovering the 'Gate' Under Market Transition: From Work-unit Compounds to Commodity Housing Enclaves. *Housing Studies*, 20(2), 235–254. <https://doi.org/10.1080/026730303042000331754>
- Wu, F. (2015). Commodification and housing market cycles in Chinese cities. *International Journal of Housing Policy*, 15(1), 6–26. <https://doi.org/10.1080/14616718.2014.925255>
- Wu, F., & Webber, K. (2004). The rise of “foreign gated communities” in Beijing: Between economic globalization and local institutions. *Cities*, 21(3), 203–213. <https://doi.org/10.1016/j.cities.2004.03.002>
- Yu, L., & Cai, H. (2013). Challenges for housing rural-to-urban migrants in Beijing. *Habitat International*, 40, 268–277. <https://doi.org/10.1016/j.habitatint.2013.05.006>
- Zeng, T., Yang, M., Li, Y., & Yao, X. (2020). Export expansion and homeownership in China: Evidence from the China Household Finance Survey. *Cities*, 104, 102765. <https://doi.org/10.1016/j.cities.2020.102765>
- Zhai, Z., Duan, C., & Bi, Q. (2007). The floating population in Beijing: An update. *Population Research*, 31(2), 30–40.
- Zheng, S., Long, F., Fan, C. C., & Gu, Y. (2009). Urban Villages in China: A 2008 Survey of Migrant Settlements in Beijing. *Eurasian Geography and Economics*, 50(4), 425–446. <https://doi.org/10.2747/1539-7216.50.4.425>
- Zheng, S., & Kahn, M. E. (2013). Does Government Investment in Local Public Goods Spur Gentrification? Evidence from Beijing. *Real Estate Economics*, 41(1), 1–28.

<https://doi.org/10.1111/j.1540-6229.2012.00339.x>

Zhu, J. (2019). *Urban Development in China under the Institution of Land Rights*.

Routledge.

Zou, G. L., & Chau, K. W. (2015). Determinants and Sustainability of House Prices: The Case of Shanghai, China. *Sustainability*, 7(4), 4524–4548.

<https://doi.org/10.3390/su7044524>

Table 1. Types of formal and informal rentals in Chinese cities

Type	Location	Tenure	Land Type	Living Conditions	Provision
Illegal rentals in urban villages (<i>cheng zhong cun</i>)	Primarily urban periphery	Insecure	Rural	Poor-quality, overcrowded housing; lack of access to public services and amenities; physically segregated	Decreasing
Basement rentals	Primarily central city	Insecure	Urban	Poor-quality, overcrowded housing; overcrowding; socially segregated	Decreasing
Group rentals (<i>qun zu fang</i>)	Primarily central city	Insecure	Urban	Poor-quality, overcrowded housing; socially segregated	Decreasing
Dormitories provided by employers	Central city and urban periphery	Mixed	Mixed	Poor-quality, overcrowded housing	
Public rental housing (<i>gong zu fang</i>)	Primarily urban periphery	Secured	Mixed	Design and constructed in compliance with local regulations; socially segregated	Limited
Formal private rentals	Central city and urban periphery	Secured	Urban	Design and constructed in compliance with local regulations	Limited

Table 2. The comparison of the bottom 40% to the city's average

	Number of households (million)		Average household size		Average per capita disposable income (yuan)	
	2015	2018	2015	2018	2015	2018
The bottom 40%	3.10	3.08	3.1	n/a	25,656	32,906
All households	7.75	7.69	2.8	2.8	48,458	62,361

Source: [Beijing Statistical Yearbook 2016](#); [Beijing Statistical Yearbook 2019](#).

Table 3. Access to public services and amenities, by rental group

	Group I (n=16, 558)	Group II (n=13, 043)	Group III (n=13, 044)	Group IV (n=13, 043)	Group V (n=13, 044)
Access to urban amenities					
Average distance to the nearest subway station (m)	1933 (1708)	1313 (1033)	988 (796)	780 (597)	695 (534)
Number of restaurants within a 1 km radius	74.7 (86.2)	109.4 (87.4)	183.8 (124.7)	271.3 (166.0)	345.7 (217.7)
Number of elementary schools within a 1 km radius	1.6 (1.7)	2.2 (1.9)	3.4 (2.6)	4.3 (2.9)	4.5 (3.1)
Number of medical services within a 1 km radius	3.4 (3.6)	4.1 (3.6)	5.9 (4.4)	7.2 (4.9)	7.6 (6.2)

Note: standard deviation in the bracket. The numbers are calculated using poi and private rental housing data in 2015.

Figure 1. The study area

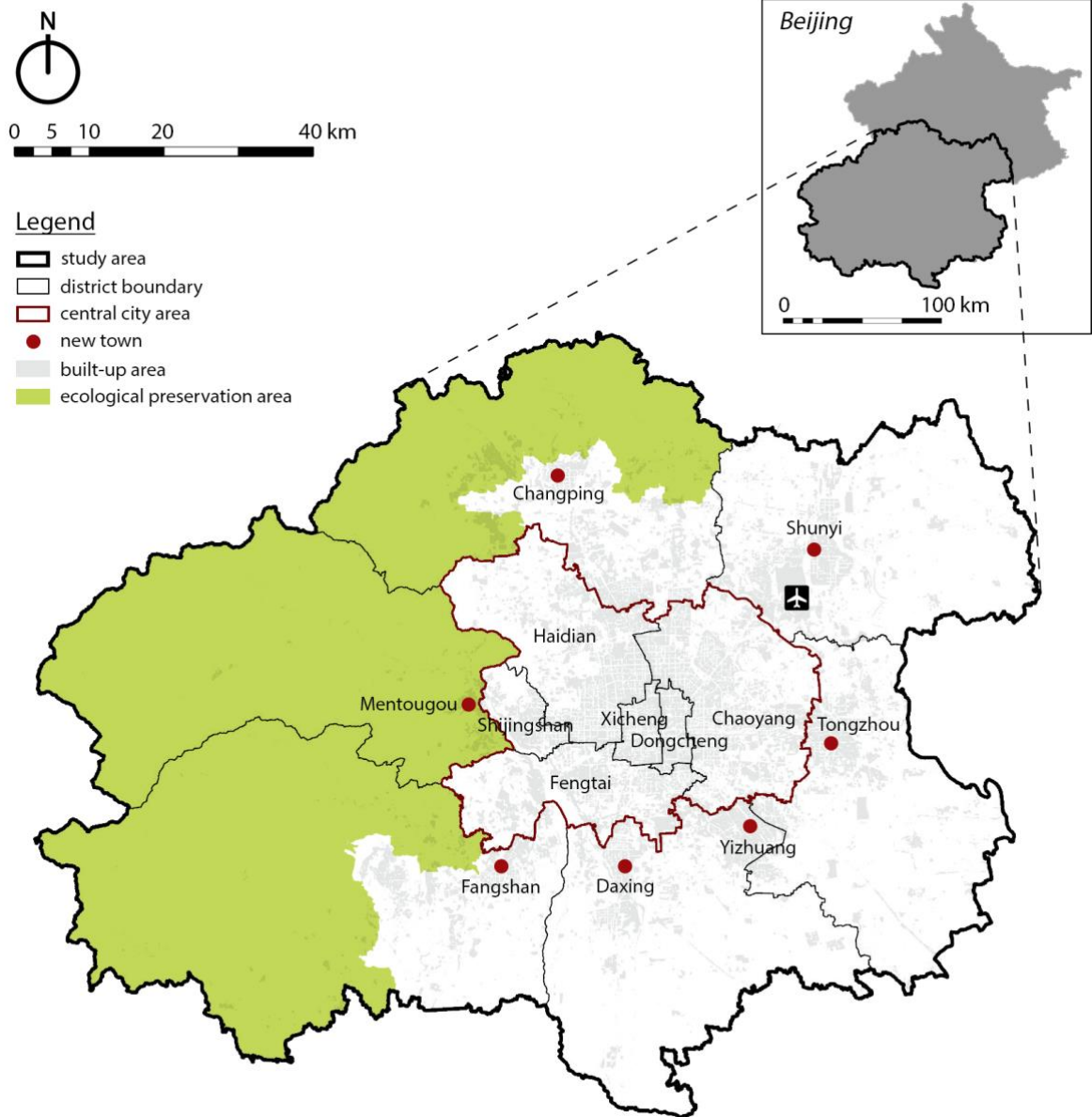


Figure 2. The median rent (yuan/m²) of formal private rentals

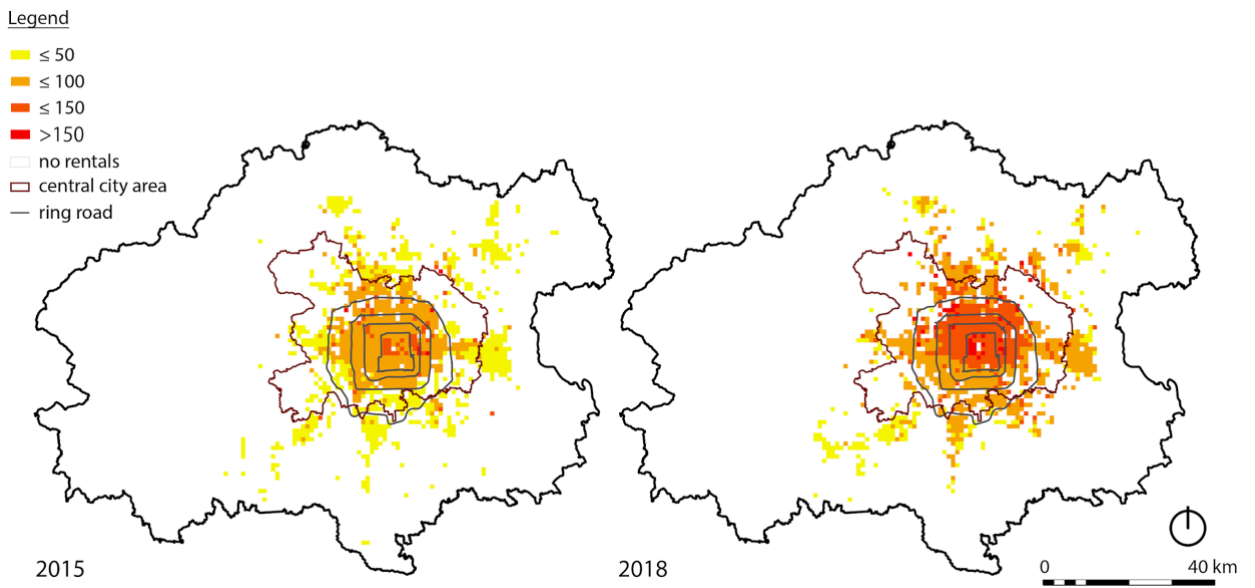


Figure 3. The concentration of affordable formal private rentals, by subdistrict

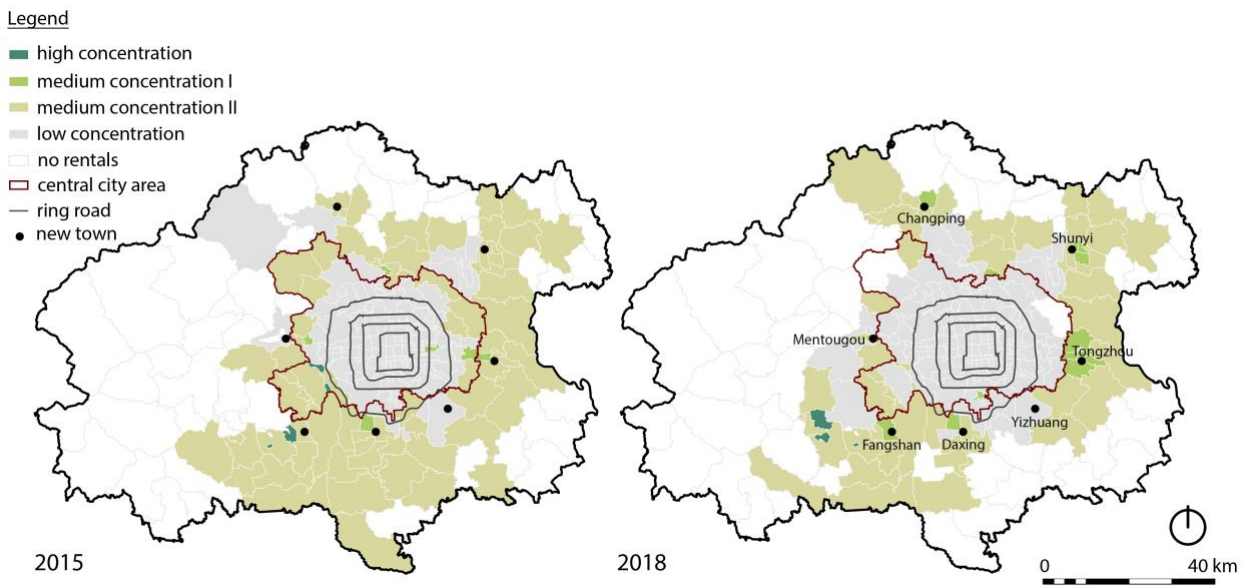
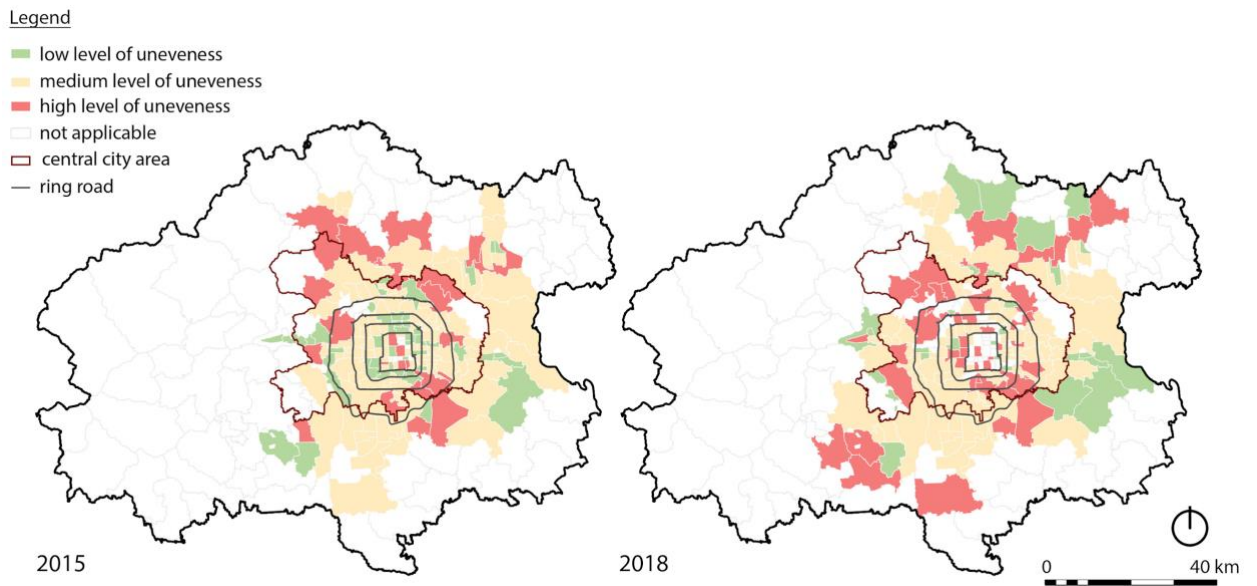


Figure 4. The uneven distribution of affordable formal private rentals, by subdistrict



Note: *ID* is only calculated for sub-districts that have both affordable and non-affordable units on the rental listing in a given year.

Figure 5. City-level Index of Dissimilarity (*ID*) of formal private rentals, by price range

