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The extreme primacy of location: Beijing's underground rental housing market



Annette M. Kim

Price School of Public Policy, University of Southern California, 650 Childs Way, RGL 305, Los Angeles, CA 90089-0626, USA

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ABSTRACT

This article analyzes Beijing's subterranean housing market within the context of the city's larger housing supply system. The emergence of this widespread market of rooms for rent in bomb shelters and basements indicates a demand for housing attributes that neither the mainstream private housing market nor public housing programs yet supply. The study collected market data about these rental units from internet ads during October 2012–September 2013 and mapped their locations, displaying their general spatial distribution. Next, a hedonic price model was deployed on this data which reveals the relative priorities and preferences in price levels, location, and housing amenities of the middle–lower income population, particularly migrants who do not possess *hukou*, Chinese urban residence rights.

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1. Introduction

Approximately one million people live in underground apartments in Beijing.¹ These subdivisions of basement and air defense shelter spaces are so prevalent, advertisements for these apartments abound on the internet as well as on signs posted around the city. Given that the population of the greater Beijing region is approximately 23 million people, the sizable population living underground has been regarded as a relatively minor phenomenon and received less policy and scholarly attention relative to other low-income informal housing phenomenon such as Beijing's urban villages which house approximately 5–6 million people. Given the lack of research, the intention of this paper is to study this sub-market in order to give a fuller account of the landscape of Beijing's housing market and the demand for housing. More complete information should be beneficial for policymakers seeking to address the complex issue of increasing affordable housing

supply. Beyond China, this unusual market provides a unique opportunity for the international scholarship about social stratification and the revealed housing preferences of low-income populations and migrants to urban areas.

Since this situation may be novel to many, this introduction first explains the phenomenon. Some Chinese cities like Beijing are unusual in terms of the vast amount of underground space that exists.² This situation is the result of a series of policies over the last 65 years that continue to today in which all new buildings are still required to construct underground spaces³ (see Appendix 1). These include two basic official types: the “common basement” (*pu tong di xia shi*) and the air defense basement (*fang kong di xia shi*).⁴ The building construction codes specify how these must be built, which include the provision of infrastructure such as electricity, water, and sewer. So, while it is well-known that

¹ Exact numbers are debated and difficult to verify. The Beijing Civil Defense Bureau estimates an underground population of 150,000. The 2009 statistics from Beijing Housing and Construction Commission counts 17,000 basements in Beijing housing 800,000 people (Xing, 2011a). Meanwhile, the Beijing construction and civil defense committees estimate underground population of 1–2 million (Xing, 2011b). As is discussed later in the article, the census has counted over 4 million “non-native” people without Beijing *hukou* that live in the city center but it is unclear what percentage of these are migrants and where they live exactly.

² While this study exclusively focuses on Beijing, underground housing is found in other northern arid cities such as Shanghai and Tianjin whose geology allows for excavation.

³ Initially started as a part of Chairman Mao's Cold War defense strategy in 1950, air defense construction then expanded in 1978s Civil Air Defense conference which stated that underground spaces should be “comprehensively planned, well constructed, and serve the needs of both peacetime and wartime.” The progression of policy phases regarding the utilization and management of Beijing's underground spaces are summarized in Appendix 1.

⁴ The air defense basement (*fang kong di xia shi*) is a more specific type of civil air defense work (*ren fang gong cheng*) that Huang and Yi (2014) termed.

Chinese cities have constructed an unprecedented number of buildings in the last several decades, this ever-increasing supply of subterranean space is less well-known.

The official policy for twenty-four years encouraged the “economic” utilization of this space during peacetime.⁵ Housing was included in the list of possible uses for this space. One could apply for a Certificate of Use for air defense shelters as well as for common basements if they met the regulatory codes and passed inspections. Such use was seen as helping with the housing shortages and housing affordability problems that have been a challenge for Chinese cities that were grappling with populations swelling with migration to urban centers, increasing incomes and housing expectations, and constrictions on land supply.

But, starting in 2010 there were a series of regulations and plans that constituted a policy reversal that no longer allows underground space to be used for housing (Zhang, 2010). In August 2010, Beijing stopped granting new use permits and made a 3 year plan to evacuate residents from basements. Evictions started taking place in 2011 particularly in the inner most urban districts that have high land values (Li, 2011; Xie, 2012). But there have been a number of challenging implementation issues such as whether to compensate the rights to occupancy that landlords had purchased, the sheer numbers of people involved, and the lack of public, affordable rental housing alternatives.

At the time of this study in 2012–2013, there was still an active and growing online market one could observe on popular Chinese websites that advertised underground housing units for rent. These ads contain rich information such as the apartment’s location, square meter area, amenities, how many stories deep the unit is, as well as the unit’s offered rental price. This study takes advantage of this readily available information to study the demand for this sub-market of rental housing in Beijing in order to find the relative housing preferences of lower-income workers.

2. Literature review to frame the research question

The challenge of developing affordable housing is a global problem, particularly as the world has been urbanizing rapidly, increasing the number of people seeking space in the city (IHC, 2009; UNCHS, 2011). As urban planning and formal markets have not kept pace with this increase, informal housing developments are not only the norm but also often the majority supplier of housing, particularly for low-income newcomers to the city (Kim, 2004, 2007; Lanjouw & Levy, 2002; Roy, 2005; UNCHS, 2003). Amidst this global policy dilemma, there have been many studies about the issue of affordable housing in the Chinese context (Huang, 2012; Qian, 2003; Song, 2011; Wang, 2000). As China has transitioned from a centrally planned economy where the state used to provide all housing through employment work units to a private housing market, the real estate sector has grown explosively. Primarily an investment vehicle, the new housing developments’ price levels are only accessible to those who have enough private savings to purchase a house with little financing. Further challenging the private provision of housing is the restrictions on land supply as the state owns all land and is trying to protect fertile farmland. As a result of the shortage, land on the urban periphery that used to be rural, and is owned by collectives rather than the state, has rapidly developed into a landscape of “urban villages” which have been a major source of lower-income, private housing for those who cannot afford to live in the city center.

As a safety net, the state also provides four types of affordable housing projects, particularly for public employees. While the number of units built is large, it meets only a small percentage of the demand and therefore there are shortages and waiting lists. Until recently, most of these programs involved apartments for sale. In 2011 the

government started a program to provide affordable rental housing (*gong zu fang*) targeted towards recent college graduates and skilled workers in key sectors such as high-tech industries (see Table 4). But, given the recent start of this program, the number of rental units is still relatively small. Fig. 1 shows the location of all the public affordable housing projects, both owned and rental, for which we could find information. As the figure shows, typical of affordable housing projects around the world, this housing is located in more remote parts of the city where land is less costly, but which also makes them less desirable. Also typical, there are reports of widespread subletting where program recipients choose to collect rental income from their publicly provided apartment rather than occupy it themselves and therefore continue to use informal housing themselves.

For all four types of official affordable housing programs, the possession of Beijing *hukou* is a pre-requisite. This household registration permit, a holdover from central planning, restricts households to the public services of the place where they have been assigned from the government. Therefore, a person born into *hukou* of large cities is at a great advantage for better education, health, and infrastructure services. Sometimes *hukou* can be changed if a state-sponsored employer applies for a change for its employee. But, for the most part *hukou* is still a significant barrier for economic opportunity.

However, with the opening of the market economy people have been moving to the large cities anyways without *hukou*. The phenomenon of China’s “floating population” is a huge demographic shift with many implications. While some might be relocating from other larger cities, the majority are rural migrants who have found informal employment and housing in the large cities. Not entitled to receive the public benefits of urban *hukou*, some observers critique that this institutional barrier has provided the low-income labor that has fueled China’s spectacular economic growth.

In terms of housing policy, the housing needs of millions of migrants in urban areas have not yet been adequately met by either the formal market or public policy (Wu, 2002, 2004). The literature on migrant housing issues has primarily focused on the urban villages that have developed on the periphery of major cities (Liu, He, Wu, & Webster, 2010; Song, Zenou, & Ding, 2008; Wang, Wang, & Wu, 2009; Zheng, Long, Fan, & Gu, 2009). However, scholars examining government census figures have deduced that roughly one-half of Beijing’s “non-native” population actually live in the urban center, approximately 4.3 million people (Liu, Wang, Cai, & He, 2013). These include people who may not have Beijing *hukou* for a variety of idiosyncratic reasons and may actually be educated, higher-income peoples from other urban areas. But, low-income migrants must also constitute a significant portion of this group which would imply that millions of migrants are actually living within 7 km of Beijing’s city center and not in the urban villages on the periphery. So, a major gap in the literature is to study the housing situation of the millions of migrants living inside Chinese cities.

Fortunately, the current Chinese administration, particularly Premier Li, has re-affirmed attention to addressing the migrant housing problem. More recently two government sponsored studies of migrant

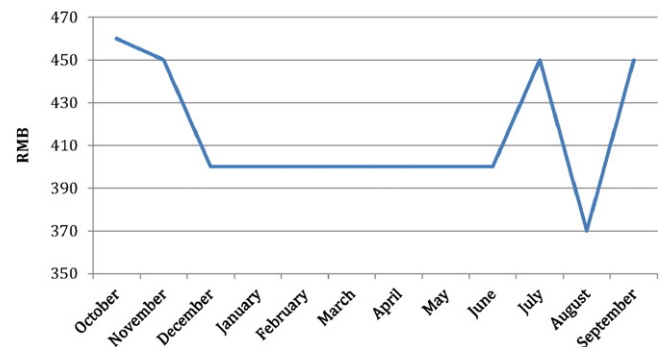


Fig. 1. Public affordable housing projects.

⁵ One of the earliest such policies was published on May 15, 1986 by the Beijing Municipal Bureau of Civil Air Defense, entitled “关于改变结合民用建筑修建防空地下室规定的通知”的实施细则” (Changes to the Implementation Rules on Constructing Air Defense Shelters by Combining with Civil Buildings).

housing have included underground housing as one of the housing types studied. They and others have focused on investigating the demographic profiles and living standards of those underground. While the populations and geographic areas of the studies vary, these start to suggest that basement tenants are generally younger, less educated, and the lowest income migrants (Huang & Yi, 2014). However, it is unclear whether underground housing is the worst housing situation. While one study done by researchers at Renmin University found that basement units are smaller than urban village housing (Zhai, Duan, & Bi, 2007) another study by researchers at Tsinghua University found the opposite (Xie & Zhou, 2012).

Since these studies focus on housing conditions and demographics, they do not frame the basement rentals as a housing sub-market. But, the market reveals the difficult choices made between different forms of low-income housing, particularly between urban village and underground housing. One of the most important characteristics of Beijing's basement housing is its location; they may provide low-cost housing located closer to the city center than urban villages. When one considers the widespread availability of urban village housing on the urban periphery, it is clear one of the choices that these renters are making is about location. As the history of public housing in many nations has shown, public housing projects can go unoccupied if located in areas that do not connect to their employment locations. Furthermore, if isolated these housing projects can create ghettos of poverty.

The spatial mismatch between housing and jobs is well-studied in international urban research. However, the Chinese spatial mismatch literature is different from the US literature which has focused on the particular mismatch challenges of particular sub-groups of the population such as minorities, women, and low-income peoples (Liu & Weng, 2008; Zhou, 2004). Until recently Chinese research has studied the “job/housing balance” problem of the aggregate population and urban area as a question of inefficient commuting patterns (Liu & Wang, 2011; Wang & Chai, 2009; Wang, Song, & Xu, 2011; Xu, Song, Fang, & Zhang, 2009; Zhao, 2010). Not too surprisingly, these studies have found that there are more employment opportunities in the center of mono-centric Beijing. As more housing is built on the periphery, commute times have been increasing. In one of the rare studies that focuses on lower-income Chinese populations, researchers found that since they do not own cars, taking the bus to work doubles their potential commute time (Lu, Zhang, & Chen, 2013).

While there have been discussions about the underground housing situation and policies in the press, and some design studies of the underground (Chen, 2002; Jin, 2010; Zhou & Zhao, 2013), little scholarly research on the Chinese underground housing market exists. The aforementioned 2012 Xie and Zhou study was important in gathering stated preferences via questionnaires from a subset of migrants. Survey respondents said that low rental price was of primary importance, and then factors such as distance to work, convenient transportation, and unit size were also important. However, revealed preferences are more reliable than stated preferences and for policy, it is important to know the relative importance of these factors, how they interact, and actual tradeoff values for distance, price, and size.

In addition to being important for Chinese housing policy, the underground housing situation of Chinese cities like Beijing also presents a situation that is exceptionally valuable for scholarly research internationally. An enduring research question in public economics concerns distinguishing between the drivers for social stratification in urban areas. Tiebout theories of preference sorting say people reveal their preferences by the choice of where they live. However, in most cities, in addition to differences in important public amenities such as school quality, neighborhoods are spatially segregated by income and ethnicity into different areas of the city which is also correlated with other factors such as commuting costs and different qualities of housing stock, variables that also feed into housing choices (Bayer & McMillan, 2012). If low-rent places are primarily available in only a few areas of the city it is difficult to analyze the tradeoffs and choices between

these variables. Beijing's unusual situation is valuable for study because we can study both lower-income and upper-income households who are living in the same x–y plane location in the city but with the lower-income people living underground on a different z plane. Given that underground apartments are distributed throughout the city, we can better study the preference tradeoffs between rental housing price, location, and size of lower-income people in Beijing.

This study takes advantage of the market data for underground housing rental units in Beijing to answer several research questions. Being a novel market, this study first asks whether this sub-market behaves like other real estate markets through the use of a standard hedonic price model of housing attributes. If so, what does the market show about the relative preferences of lower-income Beijingers/migrants? The tradeoff between price and location is an important one for the working middle-to-low-income population who face a serious challenge in trying to make a living in large, high-priced cities like Beijing. Under what circumstances is underground housing located in the city center a more desirable option than urban village housing on the periphery? The emergence of a basement rental housing market provides an unusual opportunity to understand the demonstrated demand of this population's housing priorities. Working towards the goal of improving migrant housing will require research about the spatial needs of migrants and their preferences and so this study aims to provide lessons from this market.

3. The data

How can one find a subterranean apartment to rent in Beijing? One way is to search on the internet. Units can also be found by word-of-mouth, signs posted on the street, or employers make referrals. This study took advantage of the thousands of ads posted on the internet for underground rentals which is the only systematic record of this recently developed underground market.

We examined several popular Chinese websites⁶ but found that [Ganji.com](#) had the greatest number of ads and it is also well organized and had much fuller information about the listings making it susceptible for analysis. We used the search term “地下室” or “underground unit” to find ads for subterranean housing. The ads usually give information about the monthly rent, square meter area, address, amenities as well as other interesting variables such as how deep they are underground, whether they have surveillance cameras, etc. The rental prices listed are the initial listed price and not the negotiated final rental price. It is possible that prospective renters may be able to negotiate down the rent and therefore this price may be higher than the actual rental transaction. However, unless this differential is systematically correlated with one of the other variables, this should not be debilitating to the hedonic price model and its findings that order the relative preferences for housing characteristics. Furthermore, given the large supply of rental properties and renters in Beijing and the lower transaction costs for moving, the listed price should be even closer to the transaction price than that for house sale properties which have also used hedonic price models of listed prices (Kim, 2004, 2007).

We collected web archives of ads every Sunday for a one year period from October 2012 to September 2013. The number of ads grew over the study period with approximately 50 ads on a typical Sunday in October 2012 to 240 ads on a typical Sunday in September 2013. We found we needed to do weekly archives because the older ads would disappear after about 2 months. Fortunately, because the ads were organized into a standardized format for listing information about the unit, we could employ a webharvesting application to automate the conversion of textual information in the ads into a spreadsheet database. With the original raw collections of 7312 ads, we then cleaned up the data

⁶ Others considered include 58 Tongcheng, 168 Fenlei, and Edeng. Ganji is the largest Internet gateway to classified information in China. Started in 2005 and with headquarters in Beijing, Ganji has classified ad sites for 374 major cities in China and has 15.65 million visitors daily.

Table 1
Description of variables, n = 3385.

Variable name	Definition
InPrice	Natural log of monthly rent in Chinese yuan
SqmArea	Square meter floor area of housing unit
DistTiananmen	Bird's eye distance in kilometers between housing unit and the center of the Forbidden City
Distance to subway	Distance in kilometers to the nearest subway station
Numsub	The number of unique subway lines within an 800 m radius of the housing unit
No window	Dummy variable = 1 if the ad states the unit is 1–2 stories underground; 0 = the unit is half underground and may have a window.
Heating	Dummy variable = 1 if the ad mentions heating is available.
Gas	Dummy variable = 1 if the ad mentions cooking gas is available.
Air conditioning	Dummy variable = 1 if the ad mentions air conditioning is available.
Internet	Dummy variable = 1 if the ad mentions internet service is available.
Security guard	Dummy variable = 1 if the ad mentions a security guard is on site.
Surveillance camera	Dummy variable = 1 if the ad mentions surveillance cameras.
Low season	Dummy variable = 1 if the ad occurs during December to the end of June.
Low rise	Dummy variable = 1 if the ad mentions that the building above the unit is lower than 7 stories.

deleting ads that were duplicates, that were not housing but storage spaces, and those that were missing key data needed in our model such as the unit's size, price, location, etc.⁷ In the end, we culled 3385 ads, retaining about 46% of the initial harvest.

It is important to mention that these ads are a subset of the underground housing market. The landlords that are posting ads must be educated and resourced enough to post these ads. Furthermore, many of the ads post photos of the units, advertising its relatively good quality. This also implies that the landlords must feel relatively secure about their tenure and may have already received a Certificate of Use. Therefore, this is a study of a segment of a sub-market, most likely the upper-end quality of subterranean housing.

With the locational information provided in the ads, we also generated spatial variables that are well established in the literature to be significant and to have a large impact on housing values. The distance of housing to the city center is typically one of the largest contributors to a house's value and would be especially important for a physically mono-centric city like Beijing. However, we were not sure if we should measure to the physical center because the Forbidden City and the monumental public spaces that surround it are not large sources of employment. So, we also tested whether the financial downtown, the center of Chaoyang district, might actually be the more economically potent center. However, in our preliminary regression of the first several months of ads we found that indeed the Forbidden City center was significant and Chaoyang was not. While we also entertained other polycentric nodes (Qin & Han, 2013), we found them insignificant in this underground market. This is probably due to the major ring roads and subway lines that encircle the Forbidden City and its corresponding land values (Zheng & Kahn, 2008).

Since transportation access is another important variable in hedonic price models, we manually coded the location of Beijing's 232 subway stations. Ideally we would have included data about bus stops and lines but the data was not readily available and trying to locate and pin all the stops of Beijing's 996 bus routes was too onerous a prospect. In addition, because bus transportation is so widely distributed, we suspected that proximity to a bus stop would not be as significant a variable. We inputted the location of all the housing units into GIS as described further below and then calculated data about the housing unit's distance to the city center and the nearest subway station. Since being located near more than one subway line would increase

accessibility considerably, we also calculated the number of subway lines within an 800 m radius of the housing unit which is considered a walkable distance in the Beijing context.

Table 1 defines the variables we generated. While most are self-explanatory, several require further explanation. The "No window" dummy variable = 1 if the ad states that the unit is located 1–2 stories underground. In preliminary statistical analysis, we found that whether a unit was 1 or 2 stories underground did not make any statistical difference in price. This dummy variable = 0 if the unit is partly underground (半地下室), similar to the euphemistically called "garden apartments" in the United States. These units often have a small window near the ceiling of the room. Occasionally, a unit deeply underground might also have a dark window if it happened to be located at a bomb shelter air well. However, the majority do not have any windows. So, this dummy variable could be a test for whether being completely underground without a window is a significant disamenity in this market.

We wondered if we should enter a time-lag variable for the possibility that the rents might rise during our one-year study period. Fig. 2 shows the monthly median rents of our study period from October 2012–September 2013. We were fortunate to choose a study period beginning and ending with the autumn season because instead of a general property appreciation trend, we found seasonal rents. During July–November rents are higher. Interviews with property managers and news media accounts suggest one reason for this seasonal cycle is that large numbers of young students from around the nation come to Beijing to study near the city's prestigious universities in the months prior to the national college entrance exams (北京考试院 (Beijing Examination Yuan), 2014). The popular belief is that by unofficially auditing courses as well as getting tips from university students, they will be able to perform better on this crucial exam. In addition, traditionally people return to their hometowns for the lunar new year celebrations during January–February of each year and one could assume that a higher percentage of migrants have hometowns not in Beijing. So, the low season dummy variable = 1 if the ad appears between December and June.

We took advantage of a surprising piece of information in the ads and also created a dummy variable for the height of the building above the underground unit. We tested whether higher buildings might be positively correlated with the underground unit's price since presumably the higher land value would be influencing the building height and the unit might be in a more desirable location. But, we did not find a significant relationship with taller buildings. Then, we altered the metric to a dummy variable if the building above was six stories or lower. This is the story height limit for *danwei* buildings, the traditional centrally planned work units where workers used to be assigned to live. Because of history, these tend to be located closer to the center of Beijing before it opened its economy to the private market. While these housing units were largely privatized during China's economic transition, they

⁷ We deleted ads that shared the same address, title description, and price. We also assumed ads for spaces greater than 20 m² were not for an individual unit of housing and deleted them. We also deleted ads that had outlier prices. These assumptions are conservative in that several identical units in the same complex may be vacant at the same time and therefore we would be undercounting the phenomenon. In our field investigations, we found some complexes hold hundreds of units. This could be mediated if the same unit were advertised more than once during the survey period but either raised rent levels or used different wording in the advertisement.

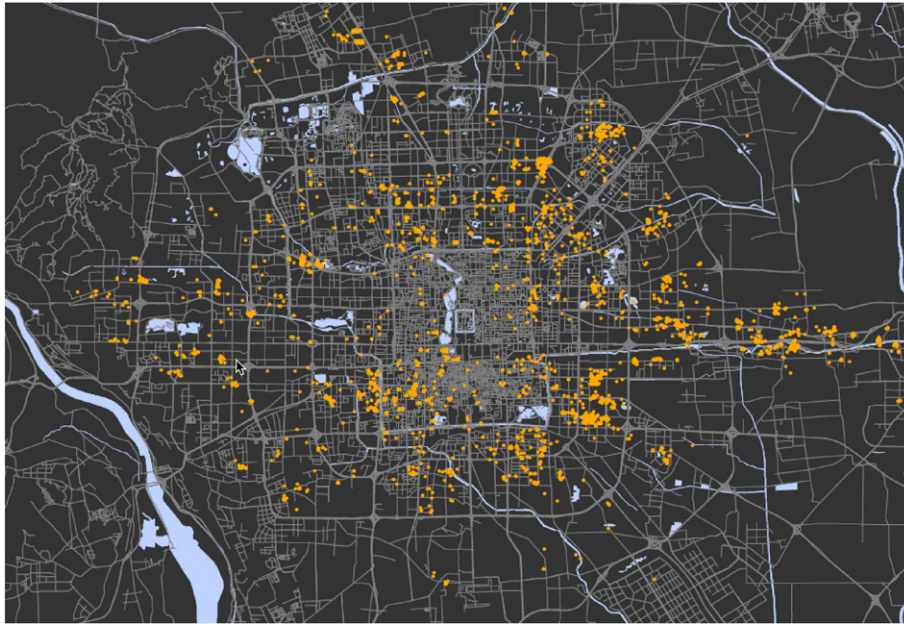


Fig. 2. Median monthly rent for Beijing underground housing units, data collected October 2012–September 2013.

were originally sold at a low price to the work unit members. China housing scholars have noted that former danwei housing seem to exhibit stronger social capital and self-governance. So, we theorized that units under danwei buildings might enjoy less threat of expropriation and therefore more secure tenure. However, the lower story danwei buildings that have not been redeveloped also tend to be older, lower quality buildings without elevators or modern infrastructure. So, the value of units under danwei buildings is an open, empirical question.

We created city district dummy variables. Even holding for the location of the unit, the district may be a significant variable. For one, they vary in terms of economic sector concentrations and employment opportunities. Also, there has been reported variations in how vigorously the city districts are implementing the underground housing eviction policy. We also created an inner suburb dummy variable to see if these might be significantly different as a group.

3.1. Mapping the location of underground housing units

The spatial variables depended upon first identifying the location of the advertised underground unit. This involved a laborious process of using the online Baidu map search engine. Chinese research assistants identified the location of the units based upon the housing development name and/or address and other locational landmarks mentioned in the advertisements. They then created pins in Google maps to mark each unit's location and then exported the locational information into GIS to generate the spatial variable discussed above.⁸

We had to resort to this laborious process because of the data sources. In preliminary testing, we found exporting locational data from Baidu maps produced greater error so we chose to pin locations in Google maps. For national security reasons, the Chinese government requires both map providers to slightly distort the longitude and latitude coordinate information in random patterns but the distortions appear to be different between the two map providers. For the purposes of

⁸ We had first tried to use APIs available for Google and Baidu maps in order to automate locating the units but found that these tools could not compute around 40% of the addresses because multiple possible locations were proffered that required human interpretation of additional information available in the ads in order to determine the location. Of those for which a unique location was identified by the algorithm, we found an error rate greater than 10%.

the hedonic price model, we only needed the relative distances between the housing unit and locations like subway stations and Tiananmen Square rather than the absolute correct location, so the spatial analysis was still useful for our study. Similarly, Chinese housing developments may be large and contain many buildings and we could not be sure under which building the unit was located. If it was possible through processes of deduction to use other locational information provided in the ads, the students would use discretion in choosing a location for the pin within the development if and only if it would not make a difference for the value of our other spatial variables, i.e. it would not change the number of subway lines that would be located within a 800 radius of various possible locations within the development or the distance to the nearest subway line or city center in kilometers. If the value of these variables would change with different possible buildings in the development, the observation was deleted.

Fig. 3 shows the location of the unique advertised units for which we could determine a location. As the map shows, underground units are well distributed throughout the city: they are not concentrated in a particular district or area of the city. This distribution reflects the opportunity created by the policy that requires all buildings in the city to continue to build underground space: this space has been subdivided into housing units all over the city.

3.2. Descriptive statistics

Table 2 shows the descriptive statistics of the dataset that we assembled about these housing units. The median unit size for underground apartments is 9.73 m². This is significant because 10 m² is Beijing's regulated minimum unit size. Although this size is much smaller than Beijing housing's overall average of 28.8 m² per person, it is more than the 6.2 m² per capita average size that currently exists in worker dormitory housing⁹ (Xie & Zhou, 2012).

⁹ To contextualize the size and standards, it is helpful to note that the size of student dormitory rooms in elite Peking University in Beijing range from 10 to 15 m² and is currently shared by for four students and used to be shared by six students a few decades earlier and eight students before that. Also, the students must bathe at a central bath house on campus similar to the community bath house in traditional hutong neighborhoods. However, with economic development, the expectations for living standards have risen and the students are vocal about their unhappiness with the living situation.

Table 2
Descriptive statistics, n = 3385.

Variable	Mean	Standard deviation	Minimum	Maximum
Monthly rent	447.766	187.155	10	1800
Square meter area	9.728	2.902	1	20
DistTiananmen	10.459	5.725	1.068	39
Distance to subway	1.091	1.299	0.005	17
Numsub	0.641	0.687	0	4
No window	0.536	0.500	0	1
Number of floors above	11.068	9.406	0	89
Low rise	0.440	0.496	0	1
Low season	0.583	0.493	0	1
Amenities				
Heating	0.449	0.497	0	1
Gas	0.056	0.230	0	1
Air conditioning	0.054	0.227	0	1
Internet	0.916	0.278	0	1
Security guard	0.268	0.443	0	1
Surveillance camera	0.445	0.497	0	1
Bed	0.984	0.125	0	1
TV	0.641	0.480	0	1
Other furniture	0.584	0.493	0	1
Refrigerator	0.136	0.343	0	1
Hot water	0.848	0.359	0	1
Clothes washer	0.258	0.437	0	1
District dummies				
Xicheng	0.061	0.239	0	1
Dongcheng	0.055	0.227	0	1
Chaoyang	0.425	0.494	0	1
Fengtai	0.309	0.309	0	1
Shijingshan	0.028	0.164	0	1
Haidian	0.197	0.398	0	1
Changping	0.049	0.215	0	1
Daxing	0.007	0.080	0	1
Tongzhou	0.072	0.258	0	1
Inner suburb dummy	0.721	0.448	0	1

The 448 RMB mean rental price also confirms that the apartments in the ads in [Ganji.com](#) are on the higher price end of migrant housing. The 2012 government study of migrant housing in Beijing found that 48.1% of migrants pay less than 300 RMB, 27% pay between 301 and 500 RMB, and 17.1% pay more than 1000 RMB per month (Xie & Zhou, 2012). In other words, these underground rental housing units are generally a higher valued type of housing for migrants in Beijing than the more common worker dormitory and urban village housing.

On average, these housing units are located less than 11 km from the city center with a standard deviation of 5.7 km, which would place these units in the central city, well within the 5th ring road. Over 72% of the ads were located in the inner suburbs. This is significant because this means that the underground market for lower-income units have the locational advantages of being in the center of the city with potentially lower commuting costs and better economic opportunities. Similarly, the average distance to the nearest subway station is a little over 1 km, which is considered within walking distance.

We found that a large portion of the housing units advertised in [Ganji.com](#) were located in Chaoyang district (42.5%), which is Beijing's central business district and where some of the highest end retail is located. We also find that roughly one-half of advertised units in [Ganji.com](#) are garden apartments with windows while the other half are one to two stories underground. On average, the units are under buildings roughly 11 stories high. But, 44% of the units are under buildings that are 6 stories or less, most likely *danwei*, former worker unit housing. And 58.3% of the ads were offered during the low season.

As for amenities, the most often mentioned ones were heat (44.9%), internet service access (91.6%), and hot water (84.8%). Nearly all of the units are furnished with a bed and some furniture. Surveillance cameras (44.5%) and security guards (26.8%) were also mentioned as an amenity.

4. Methods: the Hedonic price model

In analyzing the pattern of real estate prices, the use of hedonic price models is well established in the urban economics literature (Halvorsen & Pollakowski, 1981; Malpezzi, 2002). Because housing is a good which bundles a number of attributes, the hedonic price model is helpful in separating out the effect of these attributes in influencing the price. The market price function for housing and residential land is assumed to be:

$$P = \beta_0 + \sum \beta_i h_i + \mu$$

where P is the price for housing services with a vector of attributes h. The hedonic price function indicates the value of a collection of housing attributes and by differentiation, $\partial p(h)/\partial h$, the marginal price for any particular attribute. It is assumed that the μ 's are normally distributed.

The Alonso, Mills, and Muth's "standard urban model" found that one of the most significant factors contributing to the value of real estate was its distance to the center of the city (Alonso, 1964; Mills, 1972; Muth, 1969). In addition to prices generally falling with distance from the city center, considerable research has extended this model to include other significant variables that also impact house values such as the property's proximity to transportation access, sub-centers, and discriminated neighborhoods, as well as its amenities and age (Adair, McGreal, Smyth, Cooper, & Ryley, 2000; Cervero & Susantono, 1999; Landis, Guhathakurta, & Zhang, 1994). Other non-parametric modeling techniques have also generally confirmed these dynamics (Meese & Wallace, 1997). And these findings have been consistent in a wide variety of countries, including developing countries and transition countries ((Malpezzi, 2002; Pasha & Butts, 1996; Toda, Nozdrina, & Maddala, 1998). They have also been applied to Beijing's housing market (Yang & Shen, 2008).

As for the selection of functional form of hedonic price models, the literature has suggested two approaches: a non-linear estimation through Box–Cox transformation procedures and a linear approach, including semi-log and double-log forms (Box & Cox, 1964; Goodman & Kawai, 1984; Huh & Kwak, 1997; Kaufmann & Quigley, 1987; Rosen, 1974).

One debate in the literature is that the assumption of a parametric hedonic price model is unjustified because the economic geography of cities is uneven and so the coefficient's values and strength will vary by neighborhood, etc. A growing number of non-parametric and semi-parametric housing price models have been suggested to improve the fit. This will be especially important if the research questions seek precise estimates on real estate valuation such as the capitalization of real estate in response to public infrastructure investments (Redfean, 2009).

This paper's goal is two-fold. First, it seeks to examine whether the demand for this unusual subterranean housing sub-market behaves like the housing market above ground. There are several reasons why it may not. For one, the disamenity of being underground may be large, and this type of housing is generally so small in size and does not vary much in construction quality that the other variables standard in a hedonic price model may be more pronounced or be different in some other way. Since the goal is to identify major factors in the demand for a novel housing type and the relative preferences between factors, as in previous studies of newly formed markets (Kim, 2004, 2007), we simply employed the semi-log functional form. Second, we seek to understand the tradeoffs in housing attributes of Beijing's underground migrant population. Again, the unique opportunity of Beijing's underground housing situation is that two very different socio-economic groups are locating in the same x–y position in the city and so we can see the preferences for location of these two groups relative to other attributes, something that one cannot see in most cities that are spatially segregated and differentially resourced on the x–y plane.

In the specification of housing hedonic price models, log prices are functionally related to different types of housing attributes: the physical characteristics of the house itself, geographic location of the property within the city, and its amenities. In most hedonic house price models, the age and quality of the structure is a significant variable. Unfortunately, this data was not available. However, some researchers assert that in Beijing's housing market, housing complexes are quite similar in terms of architecture design, building structure, internal space and decoration (Zheng & Kahn, 2008). And particularly in the case of underground units, whose basic structure has followed air defense building codes, there is not much variation in structural construction while indeed there will be important differences in other measures of housing quality that we will not be able to detect, except for the stated amenities.

Therefore, if this subterranean housing market were like terrestrial housing markets, we would expect a unit's square meter floor area and amenities to be positively correlated with the value of the property. Meanwhile we expect negative and significant correlations with the unit's proximity to the city center and subway stations since proximity to these should increase its value. Another transportation access variable, the number of unique subway lines within proximity, should be positively correlated. In addition, since various districts can be more or less antagonistic or permissive towards the underground housing market we entered dummies for each city district (Li, 2011; Xie, 2012). We

also expect rental prices to be negatively correlated with a unit being deep underground, without a window.

5. Hedonic price model findings

Our statistical analysis involved a step-wise progression of fitting test variables to a base model. We developed a base model that includes the variables well established in the literature to be significant (See Table 3). It performed predictably with all the variables significant and in the expected direction. For each square meter increase in the unit's size, the rent increases 4.4%. Given that the median unit size is only 9.7 m², the positive and significant value of each additional square meter is especially not surprising. A 1 km decrease in the bird's eye distance to the city center at Tiananmen, results in a 3.9% increase in monthly rent. In addition, transportation access is significantly valuable. Each kilometer closer the unit is to a subway station the rent will increase by 1.7%. For each unique subway line within an 800 m radius of the underground unit, the monthly rent increases by 4.6%.

However, compared to these standard variables in hedonic price models, the rent was more sensitive to the disamenities of living underground and amenities that help to ameliorate the situation. If the unit is deeper underground, which means it most likely does not have a window, the rental price will be lower by 6.2% in the base model. However,

Table 3
Result estimates for hedonic price models for online underground rental housing market in Beijing, China, October 2012–September 2013 (dependent variable is the natural log of monthly rent in Chinese yuan).
Note: un-standardized coefficients are shown and t-stats are in parentheses.

	Model 1 Base model	Model 2 Amenities	Model 3 Season	Model 4 District effects	Model 5 Low-rise bldg
Constant	6.032 (252.78)**	6.126 (203.71)**	6.142 (200.14)**	6.234 (132.11)**	6.222 (130.82)**
SqmArea	0.044 (23.48)**	0.041 (21.98)**	0.040 (21.81)**	0.039 (22.09)**	0.039 (22.12)**
DistTiananmen	-0.039 (-37.47)**	-0.039 (-37.80)**	-0.039 (-37.69)**	-0.043 (-26.36)**	-0.043 (-26.31)**
Distance to subway	-0.017 (-3.48)**	-0.013 (-2.67)**	-0.013 (-2.60)**	-0.014 (-3.01)**	-0.016 (-3.28)**
Numsub	0.046 (5.26)**	0.046 (5.31)**	0.046 (5.30)**	0.061 (7.22)**	0.059 (7.01)**
No window	-0.062 (-5.58)**	-0.052 (-4.71)**	-0.051 (-4.66)**	-0.039 (-3.71)**	-0.037 (-3.58)**
Heating	-	0.082 (7.52)**	0.082 (7.52)**	0.061 (5.88)**	0.062 (5.97)**
Internet	-	-0.085 (-4.35)**	-0.083 (-4.26)**	-0.073 (-3.96)**	-0.071 (-3.84)**
Security guard	-	-0.050 (-3.82)**	-0.049 (-3.79)**	-0.040 (-3.29)**	-0.039 (-3.17)**
Surveillance camera	-	-0.050 (-4.29)**	-0.052 (-4.43)**	-0.037 (-3.31)**	-0.037 (-3.36)**
Low season	-	-	-0.028 (-2.66)	-0.014 (-1.37)	-0.014 (-1.39)
Xicheng district	-	-	-	-0.029 (-0.75)	-0.028 (-0.73)
Dongcheng district	-	-	-	-0.034 (-0.86)	-0.036 (-0.92)
Chaoyang district	-	-	-	-0.171 (-6.27)**	-0.169 (-6.21)**
Fengtai district	-	-	-	-0.076 (-2.42)**	-0.077 (-2.45)**
Shijingshan district	-	-	-	0.267 (7.32)**	0.266 (7.32)**
Haidian district	-	-	-	0.037 (1.24)	0.039 (1.33)
Changping district	-	-	-	0.107 (3.61)**	0.113 (3.77)**
Low rise	-	-	-	-	0.020 (1.89)*
Adjusted R-square	0.406	0.427	0.428	0.492	0.492

* Significance level of 0.05.

** Significance level of 0.01.

this coefficient decreased to 5.2% when other amenities were added in Model 2 which were relatively more important contributors to demand prices. Heating was a surprisingly large and significant variable. We had heard that because units are underground, they are naturally insulated and therefore warmer in the winter and cooler in the summer. Meanwhile, puzzling at first was that the other significant amenities had negative coefficients: internet access (−8.5%), security guard (−5%), and surveillance camera (−5%). But, through interviews we learned that renters have to pay additional monthly fees for services such as internet and security guards and so these should be added to the lower base rent offered. For example, one renter said she paid another 17% of her rent amount for amenities such as security guard, surveillance camera, and trash pickup.

We performed some additional analysis to further explore these amenities variables. We mapped the location of the units that did not mention the availability of internet and those that did not mention security in order to see if there was something special about their location that might explain a higher base rent. We did not observe any obvious spatial difference in the units that did not advertise these amenities. We also ran VIF collinearity tests between these variables because many of these housing amenities might be correlated with the heating variable that came out so strongly significant. However, the VIF never rose above 1.5 indicating that collinearity does not appear to be compromising the model.

In Model 3, we added our low season dummy variable which was significantly negative by 2.8%. However, this variable lost significance once we added the district dummies in Model 4. We had dropped two district dummies that had the lowest number of observations in order to avoid perfect collinearity. What was interesting to note was that some of these had much more impact than any of the variables mentioned above. In particular, districts Shijingshan (26.7%) and Changping (10.8%) seemed to have a premium. These are north and west from the city center. In our field studies, we noticed that the nicest quality underground units tended to be on the periphery under newly built buildings but we cannot study housing quality with this dataset. Meanwhile, several districts had negative coefficients: Xicheng, Dongcheng, Chaoyang, Fengtai. These districts are in the inner suburb areas to the south and the east. These were among those cited in a newspaper as being especially active in the eviction process (Li, 2011). But, there are a number of things that vary between districts so it would require further study to analyze why the district variables are so significant.

In Model 4, we entered the dummy variable for the building height above the underground unit. In Beijing's high priced real estate market and high building densities, buildings that are six stories or lower tend to be older, *danwei* housing, former working units from the 1970s and 1980s. This variable is significant at the 5% level, with a positive coefficient of 2.0%. Despite the building standards being lower both above and below ground, after holding all the variables constant, there seems to be some positive value associated with being under a lower height building, possibly because of location or tenure security.

Overall, the model performed well with an adjusted R-square of 49.23%.

6. Interpretation and discussion

6.1. A rational market

There are several empirical findings from this study. One is that the mere presence of thousands of advertisements that are well-organized on the internet and that keeps growing in number despite the policy to evict people from these spaces shows that underground housing is still a sizable phenomenon in Beijing.

Being a novel market, this study first asked the basic question of whether the subterranean rental housing market behaves like other real estate markets. By employing a standard hedonic price model of housing attributes we can see if it behaves as the many other studies

from cities around the world, all above ground. We did find that the model performed like other models, resulting in the same major significant variables with the same direction in relationships, showing that this widespread housing phenomenon is a rational market. The informal emergence of this market suggests a housing demand that is not being met by the formal market nor by the public housing programs.

The pattern of demand for the underground housing market is similar to the typical patterns above ground and previously published studies of Beijing: the highest prices are in the urban center and then generally declines with distance with some moderate poly-centricity emerging.

6.2. The demand for rental housing

Besides confirming that this a market, it is important to recognize that this dataset also reveals that there is a large demand for *rental* housing in particular. Most of the housing market growth that has been studied by scholars and most public housing programs have involved private housing ownership. Fig. 4 below shows that most of the affordable housing investment has gone towards houses for sale. While the housing market might be largely driven by the demand for housing as investment vehicles, studies have also shown that there is a strong preference among Chinese and Asian households to seek to own real estate rather than rent.¹⁰ However, this literature overshadows that there is indeed demand for rental housing, especially for lower-income people.¹¹

This is obvious given that the institution of the *hukou* does not allow migrants to apply for public housing programs. But, lower-income Beijingers have also not been able to access the formal, private housing market and there are long waiting lists for public housing programs and so even people with *hukou* have been known to live underground. Since the current administration's policy is to address the housing needs of migrants, policymakers need to know more about what are the most important characteristics for the housing needs of the urban poor.

6.3. Housing preferences of migrants

The similarity in demand patterns to terrestrial markets is interesting because in most cities, lower-income housing is often segregated into areas in the city that are also conflated with disadvantages for employment location, public services, etc. such that relative preference tradeoffs between location, commute, amenities, and housing prices cannot be revealed. In the Beijing case, because of the broad distribution of underground units, we can better see the tradeoffs.

Our hedonic price model suggests that spatial proximity to employment is paramount. It is more important than the small size and the subterranean situation of these tiny units. As previous studies of migrant housing indicate, nearly half of non-natives have found a way to live within the 5th ring road. This overriding demand for being located in the central city rather than the periphery is the impetus behind this underground housing market.

But this location decision is also one that concerns commuting costs. As urban economics has established, household location decisions involve a calculus of employment opportunity and housing and commuting costs. As in all hedonic models, our model shows that the distance to subway and the number of subway lines are significant variables: it is more desirable to have a housing unit closer to the subway and even better to be near a transfer point (5.7%). But, with Beijing's lower income population, rather than being a proxy for transportation

¹⁰ A survey conducted by South-East University and China People's Bank in 2012, entitled *China Household Finance Survey*, found that the homeownership rate in China reaches 89.68% which is far beyond the world average level of 60%. The rate in urban areas is 85.36% while in rural area it is 90%.

¹¹ I am indebted to Professor He Canfei for contributing this insight about the demand for rental housing in Beijing.

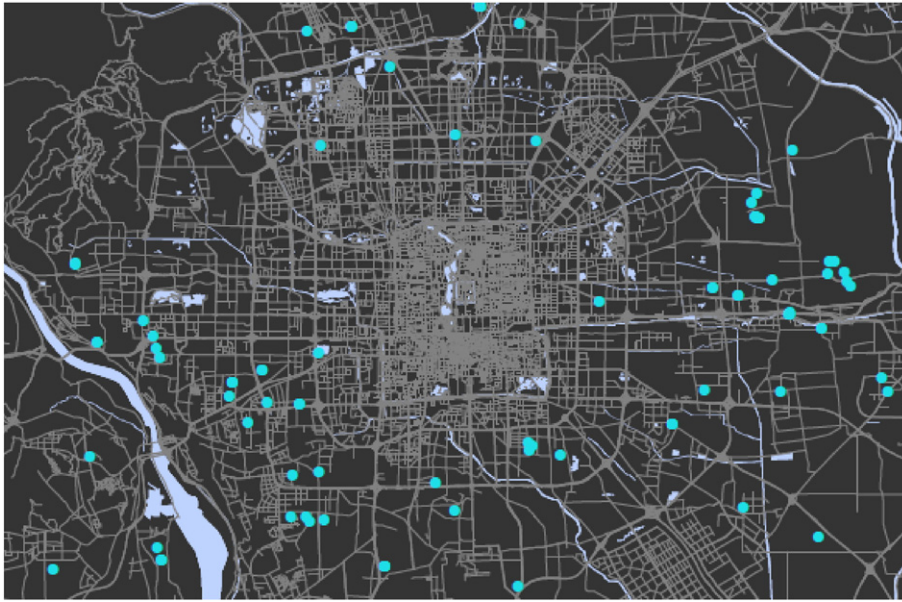


Fig. 3. Underground units in Beijing 2012–2013.

accessibility, we interpret the desirability of proximity to the subway station as further representing the employment opportunities more densely available around the transport-oriented developments. We found in interviews with underground residents conducted for another study, that most underground residents do not take the subway to work, and that the modest 2 RMB fare is still above their willingness to pay. The majority we interviewed walked or bicycled to work and chose to be near the many more employment opportunities near Beijing's transit-oriented developments. While there are cheaper housing units on the periphery, people in this market would rather choose to live underground and not undertake the onerous time or expense to commute.

However, there is clearly a tradeoff to living underground. A unit lying fully one to two stories underground is significantly negative compared to a unit that is half-underground with a window, holding all other factors constant. The most significant basic amenity that the underground population demanded was heat. Other significant amenities that are provided through extra fees are internet connectivity and security/surveillance.

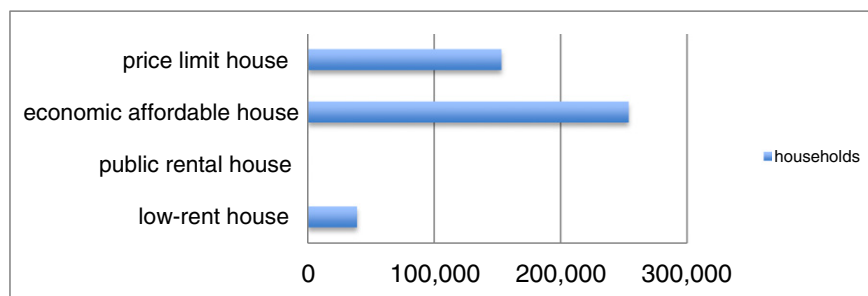
The challenge for policymakers as they start to address the migrant housing problem is where to locate housing, given the land price levels. Desirable spatial location is a perennial conundrum for affordable housing programs because the high costs of desirable locations is exactly what makes them unaffordable. Fig. 1 showed how the public housing

programs (which are only for people with *hukou*) are currently located on the outskirts.

Our descriptive statistics shows the mean rents for underground housing market has been 448 yuan. Table 4 shows what the rent levels of the public housing programs have been (Hu & Hu, 2012). We can see that while in terms of price per square meter the underground units might be more expensive, because of their roughly average 10 m² size, the total rent is much lower than what the public housing programs have been providing. This underground market is meeting the demand of people who are below the target levels of poverty of current affordable housing programs. Overall, this study confirms the government's qualitative questionnaire study of migrants who stated that price and transportation access are some of the most important factors for their needs (Xie & Zhou, 2012).

7. Conclusion

This study finds that the priority for the lower-income, often migrant population in Beijing is for rental housing located in the central city. The ability to walk and/or bike to jobs as well as low rents, both of which allow for the possibility of accumulating savings, is worth making the choice to live in small underground rooms. The data also shows that this underground market is supplying roughly 10 m² housing units, which conforms to official housing regulations.



(source: HU Hai-feng, HU Ji-ya, 2012)

Fig. 4. The number of households participating in affordable housing in Beijing by 2009. Source: Hu & Hu, 2012.

Table 4

Comparison of public affordable housing programs.
Source: Hu & Hu, 2012.

Type	Lian Zu Fang	Gong Zu Fang	Jing Ji Shi Yong Fang	Xian Jia Fang
English translation	Low-rent housing	Public rental housing	Economic affordable housing	Price limit housing
Property right	Public ownership	Public ownership	Private ownership	Private ownership
Start year of program	2001	2011	2001	2007
Average size of units in sqms.	<50	<60	N/A	<90
Average price in RMB per sqm	40 (source: website of Beijing Municipal Commission of Housing and Urban–Rural Development)	20–50 (source: website of Beijing Municipal Commission of Housing and Urban–Rural Development)	2500–5000 (rough estimation) source: SOUHU website: http://m.focus.cn/bj/loupan	8000–20,000 (rough estimation) source: SOUHU website: http://m.focus.cn/bj/loupan
Imputed monthly rent	2000 RMB	1200–3000 RMB	n/a	n/a

While this article's purpose was positivistic in terms of documenting and analyzing an empirical reality, the phenomena of a market for underground housing begs discussion of more normative issues. Just because this phenomenon is widespread does not mean it should be incorporated into public policy. It could be one of a number of desperate coping mechanisms of the urban poor who do not have the right to be in the urban areas.

One normative issue concerns how much a society should minimize living standards in order to make urban space affordable. This will become especially pressing in Asian mega-cities as the levels of density raise questions about standards of acceptable human decency as well as require policymakers and designers to think more creatively of how to reform urban space. While these underground units are actually more spacious than worker or student dormitories in Beijing (see endnote vii), aspirations and expectations have been rising with China's extraordinary economic development.

At the same time, the extent of this phenomenon challenges us with the real space constraints of contemporary Asian urbanization. If it is desirable to not allow people to live underground, we are challenged with the task of finding other spaces for roughly a million people in Beijing some of whom desperately want to live near the city center for better economic opportunities. And this is not an idiosyncratic situation. History shows that immigrants coped by living in crowded basement units as well as tenements during the west's rapid urbanization.

Our study suggests future questions to study. There is some indication that this underground housing phenomenon is cyclical and that the tenure of residents is temporary, not lasting more than several years. Furthermore, the majority of renters are single or couples without children. It could be that there is a need for life-cycle housing for people starting out in the expensive city. Furthermore, there may be other specific kinds of housing needs such as temporary stays in big cities to receive health care and education.

Beijing's underground housing phenomenon points to the fact that contemporary urbanization with its increasing density and income disparity requires the development of new housing types. The primacy of location in the demand for housing will require new property rights arrangements and governance, and the associated regulatory changes and architecture to develop effective housing solutions.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.cities.2015.11.027>.

References

- Adair, A., McGreal, S., Smyth, A., Cooper, J., & Ryley, T. (2000). House prices and accessibility: The testing of relationships within the Belfast urban area. *Housing Studies*, 15(5), 699–716.
- Alonso, W. (1964). *Location and land use: Towards a general theory of land rent*. Cambridge MA: Harvard University Press.
- Bayer, P., & McMillan, R. (2012). Tiebout sorting and neighborhood stratification. *Journal of Public Economics*, 96, 1129–1143.
- Box, G.E.P., & Cox, D.R. (1964). An analysis of transformations. *Journal of the Royal Statistical Society, Series B (Methodological)*, 26(2), 211–252.
- Cevero, R., & Susantono, B. (1999). Rent capitalization and transportation infrastructure development in Jakarta. *Review of Urban and Regional Development Studies*, 11(1), 11–23.
- Chen, L. (2002). Discussion on development and utilization of underground space in residential regions. *Underground Space*, 22(2), 181–184.
- Goodman, A.C., & Kawai, M. (1984). Functional form and rental housing market analysis. *Urban Studies*, 21, 367–376.
- Halvorsen, R., & Pollakowski, H. (1981). Choice of functional form for hedonic price equations. *Journal of Urban Economics*, 10(1), 37–49.
- Hu, H. -f., & Hu, J. -y. (2012). Overall evaluation and future development planning of Beijing affordable housing system during the "Eleventh Five-Year Plan". *Beijing Social Science*, 7–14.
- Huang, Y. (2012). Low-income housing in Chinese cities: Policies and practices. *The China Quarterly*, 212(941–964).
- Huang, Y., & Yi, C. (2014). Invisible migrant enclaves in Chinese cities: Underground living in Beijing, China. *Urban Studies*, 1–26.
- Huh, S., & Kwak, S. -j. (1997). The choice of functional form and variables in the hedonic price model in Seoul. *Urban Studies*, 34(7), 989–998.
- IHC (2009). *The challenge of an urban world*. Washington: International Housing Coalition.
- Jin, Y.Z. (2010). The application of residential district underground space. *Shanxi Architecture*, 36(27), 16–17.
- Kaufmann, D., & Quigley, J.M. (1987). The consumption benefits of investment in infrastructure: The evaluation of sites-and-services programs in underdeveloped countries. *Journal of Development Economics*, 25, 263–284.
- Kim, A.M. (2004). A market without the "right" property rights: Ho chi minh city, Vietnam's newly-emerged private real estate market. *Economics of Transition*, 12(2), 275–305.
- Kim, A.M. (2007). North versus south: The impact of social norms in the market pricing of private property rights in Vietnam. *World Development*, 35(12), 2079–2095.
- Landis, J., Guhathakurta, S., & Zhang, M. (1994). *Capitalization of transit investments into single-family home prices: A comparative analysis of five California rail transit systems: Institute of Urban and Regional Development*. University of California at Berkeley.
- Lanjouw, J.O., & Levy, P.I. (2002). Untitled: A study of formal and informal property rights in urban Ecuador. *The Economic Journal*, 112(October), 986–1019.
- Li, Y. (2011). Millions of tenants were cleaned out and have nowhere to go their life was miserable. *China Economic Weekly* May 31, 2011. (Retrieved from http://news.xinhuanet.com/fortune/2011-05/31/c_121476984.htm).
- Liu, W., & Weng, J. (2008). Western space mismatching hypothesis and its inspiration on China's city development. *Planners*, 24(1), 91–94.

- Liu, X., Wang, M., Cai, J., & He, M. (2013). An analysis on the spatial structure of non-native permanent population of Beijing Metropolitan Area in 2000–2010. *Urban Development Studies*, 20(10), 86–93.
- Liu, Y., He, S., Wu, F., & Webster, C. (2010). Urban villages under China's rapid urbanization: Unregulated assets and transitional neighbourhoods. *Habitat International*, 34(2), 135–144.
- Liu, Z., & Wang, M. (2011). Job accessibility and its impacts on commuting time of urban residents in Beijing: From a spatial mismatch perspective. *Acta Geographica Sinica*, 2011(4), 457–467.
- Lu, B., Zhang, C., & Chen, T. (2013). Study on changes in job accessibility for the urban low-income: A case study of Beijing. *City Planning Review*, 37(1), 56–63.
- Malpezzi, S. (2002). Hedonic pricing models: A selective and applied review. In K. Gibb, & A. O'Sullivan (Eds.), *Housing economics: Essays in honor of Duncan MacLennan*. Oxford UK: Blackwell.
- Meesse, R., & Wallace, N. (1997). Nonparametric estimation of dynamic hedonic price models and the construction of residential price indices. *American Real Estate and Urban Economics Association Journal*, 19(3), 308–332.
- Mills, E.S. (1972). *Theory of land rent and land use urban economics*. Glenview IL: Scott and Foresman.
- Muth, R.F. (1969). *Cities and housing*. Chicago: University of Chicago Press.
- Pasha, H.A., & Butts, M.S. (1996). Demand for housing attributes in developing countries: A study of Pakistan. *Urban Studies*, 33(7), 1141–1154.
- Qian, Y. (2003). Chinese affordable housing policy analysis: Economical housing and cheap rental housing [中国住房保障政策研究——经济适用房与廉租住房]. *China Real Estate 中国房地产*, 8, 57–60.
- Qin, B., & Han, S.S. (2013). Emerging polycentricity in Beijing: Evidence from housing price variations, 2001–05. *Urban Studies*, 50(10), 2006–2023.
- Redfean, C. (2009). How informative are average effects? Hedonic regression and amenity capitalization in complex urban housing markets. *Regional Science and Urban Economics*, 39, 297–306 (2009).
- Rosen, S. (1974). Hedonic prices and implicit markets: Product differentiation in pure competition. *The Journal of Political Economy*, 82(1), 34–55.
- Roy, A. (2005). Urban informality. *Journal of the American Planning Association*, 71(2), 147–158.
- Song, W. (2011). The social issues behind affordable housing spatial distribution in big cities and the harnessing approaches [大城市保障性住房空间布局的社会问题与治理途径]. *Urban Studies 城市发展研究*, 18(8), 103–108.
- Song, Y., Zenou, Y., & Ding, C. (2008). Let's not throw the baby out with the bath water: The role of urban villages in housing rural migrants in China. *Urban Studies*, 45(2), 313–330.
- Toda, Y., Nozdrina, N., & Maddala, G.S. (1998). The auction price of apartments in Moscow: Hedonic estimation in disequilibrium. *Economics of Planning*, 31(1–14), Kluwer Academic Publishers.
- UNCHS (2003). *The challenge of slums*. Nairobi, Kenya: United Nations Human Settlements Programme.
- UNCHS (2011). *State of the world's cities 2010/2011*. Nairobi: United Nations Centre for Human Settlements.
- Wang, D., & Chai, Y. (2009). The jobs–housing relationship and commuting in Beijing, China: The legacy of Danwei. *Journal of Transport Geography*, 17(1), 30–38.
- Wang, E., Song, J. -p., & Xu, T. (2011). From “spatial bond” to “spatial mismatch”: An assessment of changing jobs–housing relationship in Beijing. *Habitat International*, 35(2398–409).
- Wang, Y.P. (2000). Housing reform and its impacts on the urban poor in China. *Housing Studies*, 15(6), 845–864.
- 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.
- Wu, W. (2002). Migrant housing in urban China choices and constraints. *Urban Affairs Review*, 38(1), 90–119.
- Wu, W. (2004). Sources of migrant housing disadvantage in urban China. *Environment & Planning A*, 36, 1285–1304.
- Xie, L. (2012). The number of migrant workers in Beijing declined by 600,000, and the new policy drove “mouse tribe” out of the basement. September 3, 2012. Retrieved from <http://finance.ifeng.com/news/region/20120903/6979864.shtml>
- Xie, X., & Zhou, L. (2012). Study on housing demands of migrant workers in key industries in Beijing. *Paper presented at the 2012 China Urban Planning Annual Conference Proceedings, Beijing*.
- Xing, F. (2011a). Retrieved from <http://news.qq.com/a/20110114/000529.htm>
- Xing, F. (2011b). (January 28, 2011). Retrieved from <http://news.sina.com.cn/c/sd/2011-01-28/135021891054.shtml>
- Xu, T., Song, J. -p., Fang, L. -n., & Zhang, N. (2009). Spatial mismatch between housing and employment in Beijing. *Scientia Geographica Sinica*, 29(2), 174–180.
- Yang, Z., & Shen, Y. (2008). The affordability of owner occupied housing in Beijing. *Journal of House and the Built Environment*, 23(1008), 317–335.
- Zhai, Z., Duan, C., & Bi, Q. (2007). The floating population in Beijing: An update. *Population Research*, 31(2), 30–40.
- Zhang, R. (2010). *Beijing government to shut down civil air-defense shelters and improve the living environment for the “mouse tribe”*. Beijing Times November 17, 2010. (Retrieved from http://news.xinhuanet.com/photo/2010-11/17/c_12784122.htm).
- Zhao (2010). The spatial mismatch of residence and employment in Beijing and its reason. *Urban Problems*, 5, 56–59.
- Zheng, S., & Kahn, M.E. (2008). Land and residential property markets in a booming economy: New evidence from Beijing. *Journal of Urban Economics*, 63(2008), 743–757.
- 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.
- Zhou, J., & Zhao, R. (2013). Exploration on development and utilization of Beijing different types underground spaces. *Shanxi Architecture*, 39(14), 4–6.
- Zhou, J. -p. (2004). Spatial mismatch hypothesis and employment of the disadvantaged social group: Research evolution in the US and implications for China. *Urban Research*, 9, 8–14.
- 北京考试院 (Beijing Examination Yuan) (Producer). (2014). 2014 北京考研:1月4日开考 考生112448人 (Beijing graduate school entrance examination started on 4th Jan, 112448 students attended the exam).