

Spatial Mismatch or Not? Evidence from Public Janitors in Xi'an, China

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Abstract: Research on the spatial mismatch experienced by low-income minority residents is US-centric. However, spatial mismatch is not necessarily an appropriate term when considering the situation of low-wage workers in cities of northwestern China where there is higher proximity between jobs and housing and lower levels of residential segregation. This paper empirically examines the jobs-housing spatial relationship for one of the most typical low-wage groups, namely, public janitors, in Xi'an, China. Also, the causes of the jobs-housing spatial relationship are discussed in detail. Individual-level data based on in-depth interviews and questionnaires, as well as the GIS network analysis method, are used to provide baseline analyses of the jobs-housing spatial relationship. Results indicate that there is no jobs-housing spatial mismatch for public janitors in Xi'an. This can be implied from the short commuting distance and time. A basic cause is that most public janitors rent low-cost accommodation in villages-in-the-city, and in old residential quarters, near to their places of work. Other causes lie in off-peak commuting and high sensitivity to commuting distance due to the greater extent of non-motorized commuting modes. The conclusions, based on a large number of social surveys, are an illuminating analysis of the spatial mismatch issue among low-wage workers in Chinese cities.

Keywords: spatial mismatch; jobs-housing spatial relationship; commuting distance; commuting time; low-wage workers; Xi'an, China

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1 Introduction

The spatial mismatch hypothesis (SMH) is a classic theory focusing on inner-city poverty, social segregation, and unemployment (Kain, 1992). Research on the SMH was originally carried out under the specific background of suburbanization in US cities. US researchers consistently dominate the SMH field; their studies on spatial mismatch are rich and in-depth. In China, since the economic reform in 1978, with fast urban sprawl affecting the location of housing and jobs, many researchers began to take an interest in the SMH. However, there is

still limited research examining how the SMH may have affected low-wage groups in China. Although some researchers have indicated that low-income workers encounter spatial mismatch (Fan et al., 2014; Zhang and Man, 2015; Zhou et al., 2016), the conclusion was drawn mainly from examinations of large cities in eastern or southeastern China, such as Beijing and Guangzhou. Additionally, spatial mismatch is not necessarily an appropriate term when considering the situation of low-wage workers in the cities of northwestern China, many of whom do not live in isolated geographical areas. Therefore, the jobs-housing spatial relationship of

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low-wage groups in the cities of northwestern China and its fundamental causes remain to be further discussed.

The SMH was first proposed by Kain in the 1960s. Taking Chicago and Detroit as examples, Kain (1968) maintained that the postwar suburbanization of jobs and housing market segregation have acted together to cause a surplus of workers compared to the number of available jobs in the city center where blacks are concentrated. This situation likely brought lower wages, higher joblessness, and longer commuting distances for many black workers.

Since then, superior methods were applied to the SMH. One of the most commonly used methods was to compare differences in employment status (i.e., employment rates, job density, and wages), jobs-housing distances, and job accessibility between the minority (i.e., black people) and the majority (i.e., white people) (Hughes and Madden, 1991; Ihlanfeldt and Sjoquist, 1991; Ihlanfeldt, 1993; Immergluck, 1998; Preston and McLafferty, 1999; Hu, 2015). Also, commuting time and commuting mode were also widely applied to examine the SMH (Holzer, 1991; DeRango, 2001; Gottlieb and Lentnek, 2001). Additionally, research topics not only referred to African-Americans but also to other groups, such as women (Thompson, 1997; Preston and McLafferty, 1999), the urban poor (Covington, 2009; Gobillon and Selod, 2014), and low-wage workers (Cooke and Shumway, 1991; Sanchez, Shen, and Peng, 2004), Hispanics (Ihlanfeldt, 1993), and Latinos (McLafferty and Preston, 1992). In Britain, scholars tend to be more concerned with inner-city low-wage workers (Houston, 2005).

Many studies have gone a step further to investigate the mechanism of spatial mismatch. Findings from research on Atlanta by Ihlanfeldt and Young (1996) indicate that the spatial mismatch could be caused by poor job accessibility, implying a shortage of public transport from the inner urban areas to the white suburbs. Meanwhile, Holzer and Ihlanfeldt (1996) maintained that the distance between the homes of black workers and the locations of their white employers positively affected the SMH in Boston, Atlanta, Los Angeles, and Detroit. In research across some metropolitan areas in the USA, some studies demonstrated that the commuting mode is a significant reason for spatial mismatch (Taylor and Ong, 1995; Stoll, 1999). Ihlanfeldt (1997) found that spatial mismatch, or why black workers ex-

perience unemployment, lies in their closed social networks. Furthermore, discrimination in the job and housing markets is also a critical factor (Ihlanfeldt and Sjoquist, 1998; Hellerstein et al., 2008). By reviewing theoretical models related to the spatial mismatch literature, Gobillon, Selod, and Zenou (2007) identified seven different mechanisms in a spatial mismatch context from the perspective of workers and of firms, indicating that the mechanisms called for further empirical tests (Gobillon et al., 2007). Houston held that the spatial mobility barriers for low-wage workers and firm relocation are two important causes of spatial mismatch in Britain (Houston, 2001).

In China, emerging studies indicate that the SMH is also a growing problem over the past two decades in Beijing and Guangzhou (Wang and Chai, 2009; Li, 2010; Wang et al., 2011; Fan et al., 2014; Zhou et al., 2016). However, only a few research studies focused on low-wage groups. Zhou et al. (2016) are among the small number of researchers who examined spatial mismatch among low-income workers. They found that after the reform and relocation of state-owned enterprises in Guangzhou, many former employees became typical of the marginalized urban poverty groups, experiencing jobs-housing spatial mismatch and barriers to housing change and job relocation (Zhou et al., 2016). Fan et al. (2014) showed that low-income workers in Beijing also face apparent spatial mismatch because accommodation is more widely dispersed than jobs. Also, the central city-focused public transit system for the dispersed low-income workers is insufficient (Fan et al., 2014). Bi et al. (2019) found that the fundamental cause of distance from employment is not entirely the result of geographical segregation; it is also related to social segregation.

Based on these shortcomings, this article presents an empirical examination of the jobs-housing spatial relationship of public janitors in Xi'an, China. Public janitors constitute one of the most typical low-wage groups. The majority of public janitors in Xi'an earn only 5 to 6 yuan (RMB) (CNY) an hour, which is much lower than the minimum wage in central Xi'an. According to the Chinese National Bureau of Statistics in 2018, the minimum wage in central Xi'an was about CNY 17 an hour (National Bureau of Statistics, 2018). Also, unlike other low-wage workers with unstable jobs, or those who live where they work, public janitors in Chinese cities gener-

ally have regular job locations and stable housing, and their accommodation is in a different location to their place of work.

2 Materials and Methods

2.1 Study area

Xi'an is the provincial capital of Shaanxi Province in the northwestern China. The study area in this paper is Xi'an central urban area (Fig. 1). It is composed of seven urban districts (Qu): Xincheng, Beilin, Lianhu, Yanta, and the highly urbanized areas of Weiyang, Baqiao, and Chang'an. Hereafter the study area is referred to as Xi'an; it covers an area of about 593.95 km².

2.2 Data sources

In order to obtain the exact locations of public janitors' jobs and residences (Origin-Destination trips data source), as well as other information about individual socio-economic background, travel modes, travel time and time expense, housing type and factors influencing housing choice, *etc.*, public janitors completed 372 paper questionnaires and 372 in-depth interviews. Finally, 340 questionnaires were deemed to be acceptable. The paper questionnaires were conducted from April to July of 2018.

The metro lines (up to December 2018, there were

three lines in Xi'an) and three sections of the second ring road in Xi'an were chosen for investigation purposes. These choices improve efficiency and widen the scope of our investigation. They also ensure the equal distribution of samples. It is noteworthy that there are no samples on some sections of the metro lines (Fig. 2a). This is because we traveled along the metro lines from the starting stations to the terminals. At lunchtimes, there were no public janitors around, so we continued to the next stations. We conducted a 26-sample pilot survey in the southeast part of Xi'an to test the effectiveness of the survey instrument (Fig. 2a). The instruments were shown to be effective. Therefore, we included them in this research.

2.3 Methodology

2.3.1 Measurement of commuting distance

To build the database of jobs and places of residence in ArcGIS, we used Baidu Maps (map.baidu.com), a popular search engine in China similar to Google Maps. The street network was also inputted into ArcGIS based on Baidu Maps (map.baidu.com). We prepared a shapefile database in ArcGIS to calculate the street network distances from residences to jobs. We compiled shapefiles for (a) housing locations for 340 public janitors (Fig. 2b), (b) job locations for 340 public janitors (Fig. 2a), and (c) street network (Fig. 2). The street net-

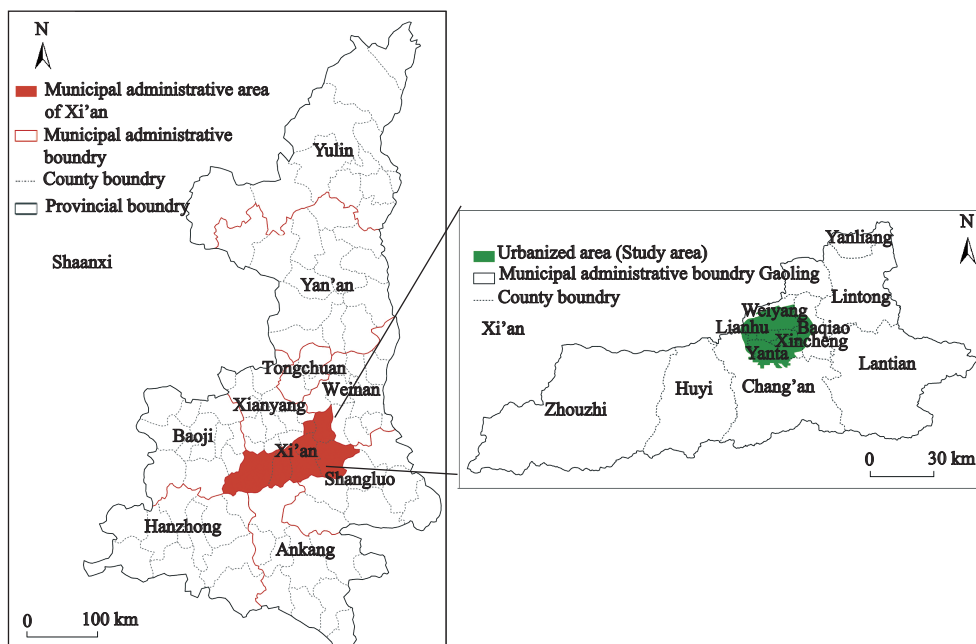


Fig. 1 Location of Xi'an City

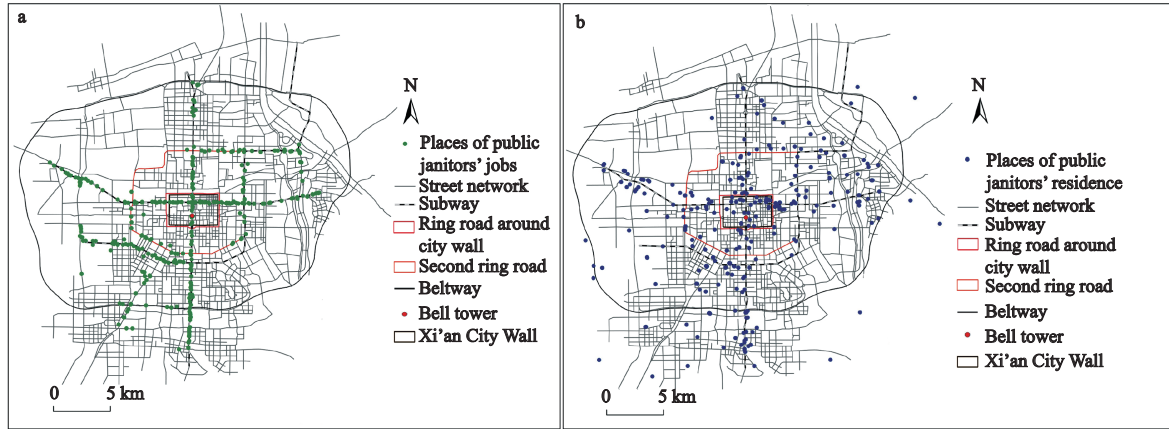


Fig. 2 Spatial distribution of public janitors' jobs (a) and places of residence (b)

work distance from housing to work is the actual commuting distance. The distance was calculated using the OD Cost Matrix tool in ArcMap.

2.3.2 Measurement of commuting direction

Commuting direction can reflect the spatial relationship between jobs and housing. If the distance from housing to the city center (d_h) is longer than the distance from the workplace to the city center (d_j), the commuting direction points toward the city center (Fig. 3a). In contrast, if the distance from housing to the city center (d_h) is shorter than the distance from the workplace to the city center (d_j), the commuting direction will point away from the city center (Fig. 3b). In other words, if d_h divided by d_j is more than 1, the commuting direction points toward the city center; however, if the result is less than 1, the commuting direction points away from the city center. When the result is 1, jobs and housing coincide spatially.

The place that most closely resembles a CBD (Central Business District) is the Bell Tower, commonly recognized as marking the city center of Xi'an with the highest concentration of commercial and office buildings around it. The Bell Tower is also the mid-point of

the Xi'an City Wall. The identification of the CBD location helps in examining the commuting direction. The distances of jobs or housing from the Bell Tower are also computed using the OD Cost Matrix tool in ArcMap.

3 Commuting Features and Jobs-Housing Spatial Bond of Public Janitors

3.1 Spatial and temporal features of commuting

3.1.1 Commuting distance and time spent

The measurement results of commuting distances show that many public janitors have an extremely short journey-to-work distance. As the commuting distances are not normally distributed, the median commuting distance was calculated to represent the average commuting distance. It was calculated that the median commuting distance is 1.55 km. As the commuting distance increases, the number of public janitors decreases accordingly (Fig. 4). The figure shows that there are 130 public janitors whose commuting distances are less than 1.2 km, a ratio of almost 38.24%. As the commuting distance in-

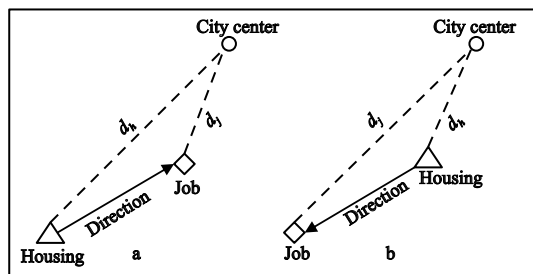


Fig. 3 Commuting direction pointing toward (a) and away from (b) city center

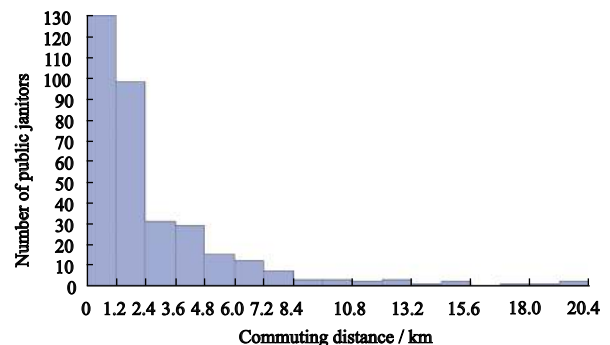


Fig. 4 Histogram of public janitors' commuting distances

increases to 2.4 km, the ratio grows up to 67.06%. That is to say, more than half of the public janitors travel a very short distance, usually under 2.4 km, to their place of work. When the commuting distance exceeds 2.4 km, the number of public janitors drops sharply.

As Fig. 5 shows, almost half of the public janitors only take 10 to 20 min to arrive at their workplace. The proportion of public janitors traveling less than 10 min accounts for about 20% of the total number of public janitors; nearly the same number of public janitors spends 20 to 30 min traveling to work. However, very few public janitors commute for more than 30 min.

3.1.2 Commuting direction

It is found that 60.59% of the public janitors' commuting directions point toward the city center. Therefore, it can be stated that the great majority of public janitors live farther away from the city center than the location of their workplaces (Fig. 6). This conclusion also conforms to the usual pattern of a general decline in house price from the city center to the periphery.

According to the median distances to the city center, public janitors whose commuting directions point toward the city center (8.23 km) live farther away from the city center than those with commuting directions moving away from the city center (5.14 km). Furthermore, the median commuting distance of public janitors

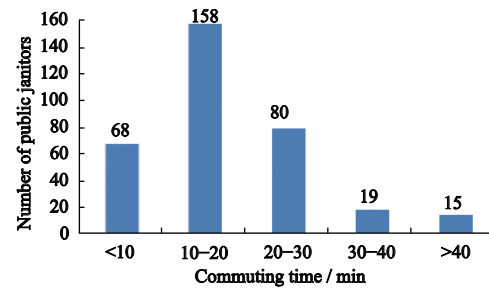


Fig. 5 Number of public janitors with different commuting times

whose commuting directions move away from the city center is 1.52 km, shorter than that of public janitors whose commuting directions point toward the city center (the median commuting distance is 1.62 km).

The above research shows that the mean journey-to-work distance for public janitors is only 1.55 km. More than half of the public janitors spend less than 20 min on the journey to work. Additionally, most public janitors walk or cycle to work. However, according to some existing research, the average travel distance for the general public in Xi'an is now 5.1 km (Zhou et al., 2013). More than 52.8% of the residents have to commute over 33 min to work (Zhu et al., 2015). Additionally, the residents in Xi'an have to use public transport (i.e., subway, bus) or private cars to commute a long distance (Zhu et al., 2015). These findings indicate that public

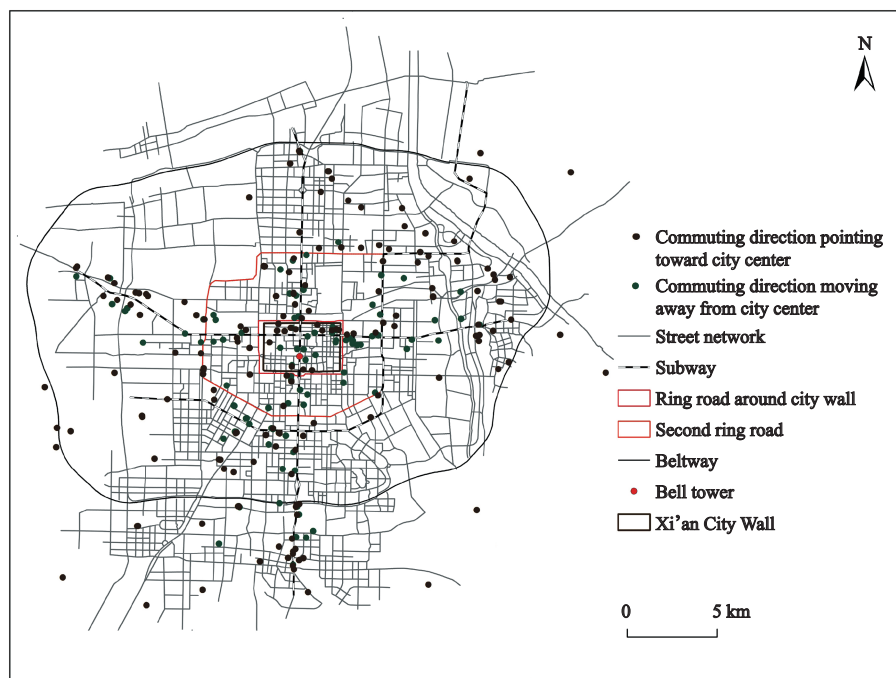


Fig. 6 Distribution of public janitors with different commuting directions

janitors in Xi'an have almost no jobs-housing spatial mismatch.

3.2 Causes of jobs-housing spatial bond

In short, there is no obvious jobs-housing spatial mismatch for public janitors in Xi'an due to the short commuting distance and the small amount of time involved. Furthermore, there are three important reasons (i.e., housing choice, commuting time, and sensitivity to commuting distance) for the short commuting distance and the small amount of time, resulting in a good spatial bond between jobs and housing for public janitors.

3.2.1 Housing choice

Housing choice is one of the most critical reasons for jobs-housing bond. Analyses indicate that, due to their low wages, the vast majority of public janitors in Xi'an are not homeowners. Also, most public janitors are migrant workers who, as a result of China's *hukou* registration system, have limited access to government-subsidized accommodation.

Therefore, renting is the inevitable choice for most public janitors. The number of public janitors who rent is 256, roughly 75.29% of the sample (Fig. 7). Among

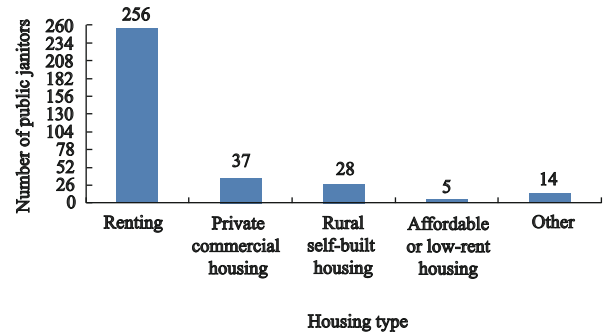


Fig. 7 Number of public janitors with different housing types

the 256 public janitors who rent, 42.97% do so because of low rent, and 49.61% do so to shorten commuting distances, thereby reducing commuting expenses. So, where do public janitors find low-rent housing close to their workplaces?

The answer lies in two types of communities. The first is villages-in-the-city (*chengzhongcun* in Chinese). The second is the old residential quarters. According to our survey, all but 56.64% of the 256 public janitors live in the Xi'an villages-in-the-city (Fig. 8a). The proportion of public janitors who rent in the old residential quarters is 35.16%. The median commuting distances

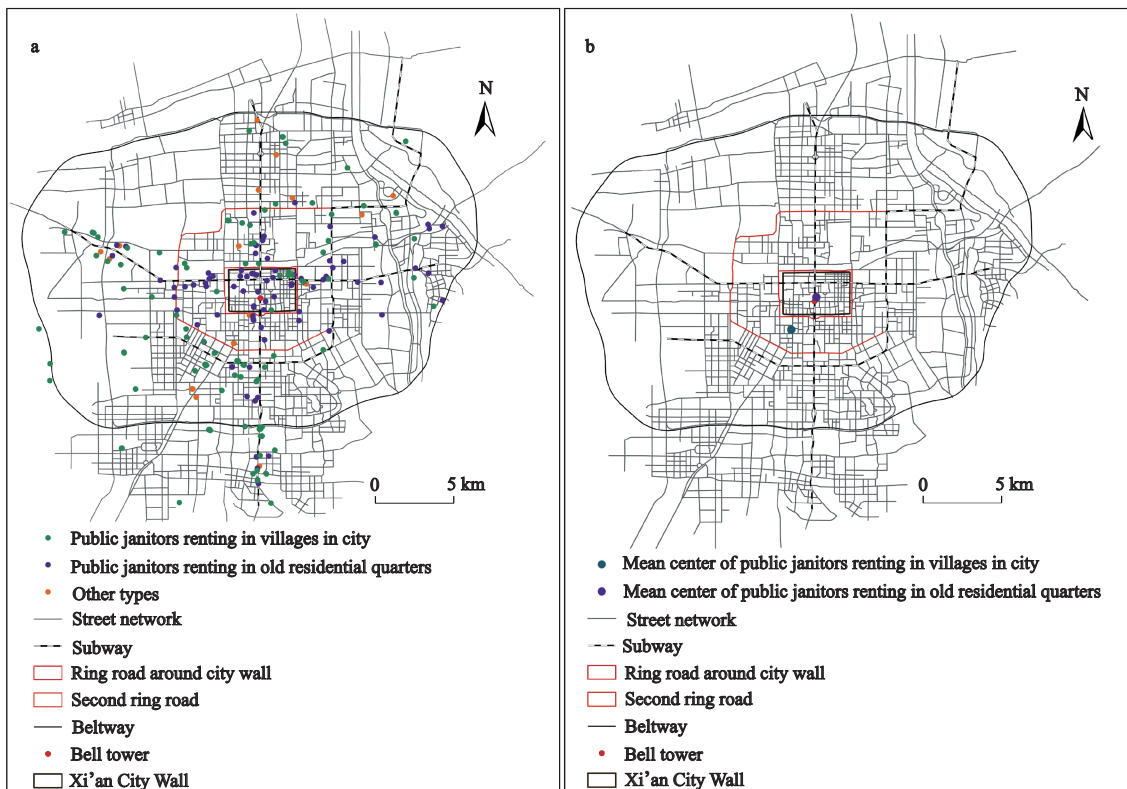


Fig. 8 Distribution of public janitors renting different housing types (a) and the mean center (b)

for public janitors who rent in villages-in-the-city and in the old residential quarters are 1.46 and 1.2 km. Both figures are significantly lower than the average level (1.55 km as calculated). Fig. 8b indicates that the mean center for public janitors renting in the old residential quarters is located almost in the city center. In contrast, the mean center for those who live in Xi'an villages tends to be situated in the southwest, relatively far from the city center.

According to Fan et al. (2014), villages-in-the-city constitutes a reason for the spatial mismatch of migrant workers in Beijing. This is because most migrant workers in Beijing live in villages-in-the-city located in the periphery of the city center. Therefore, they have to travel a long journey to the job-concentrated city center. However, unlike Beijing, Xi'an generally does not have the strong administrative and economic power needed to remove the many villages in the city center. Therefore, Xi'an villages are more widely distributed in the city periphery and city center (Fig. 9). More importantly, Xi'an villages and the old residential quarters are not

located in segregated geographical residential areas. They are generally mixed spatially with other residential spaces and job clustered areas, such as expensive residential areas, high-rise downtown office building areas, and so on. Therefore, the spatial mismatch degree for migrant workers living in the Xi'an villages and in the old residential quarters is currently much lower than in Beijing.

Villages-in-the-city constitute a specific urbanization phenomenon in China. Rural land, usually collectively owned by villagers, is distributed to farmers for building houses and for cultivation. The former land-use type is considered as residence-based; the latter is considered to be farmland. The rapid urban land expansion caused rural land around cities to be occupied by built-up area. After being requisitioned by city governments to be legally state-owned, rural land can be used for urban construction by property developers. When governments and property developers experience a shortage of finance, farmland is more likely to be used for construction than residence-based land due to the lower cost.



Fig. 9 Distribution of villages-in-the city in Xi'an

Therefore, residence-based land is gradually surrounded by urbanized areas transformed from farmland into village-in-the-city. When the farmers receive compensatory payments for their farmland from government and property developers, most of them move to other urban residential quarters with better living conditions. They then rent their previous self-built houses in villages-in-the-city at a low price. That is why many low-income groups, especially migrant workers, live in villages in the cities of China.

Villages-in-the-city are usually occupied by hundreds of thousands of low-rise housing units developed by native villagers. These low-rise buildings are always distributed at random, and they are very crowded. Their landscape is often in sharp contrast with the surrounding urbanized areas where the buildings are relatively high and are distributed regularly with more open space. These areas can be easily observed on Baidu Satellite Images (Fig. 10), similar to Google Satellite Images. Fig. 10 shows the Baidu Satellite image of one of the villages in Xi'an.

A small number of public janitors rent their current housing for other reasons. For example, 12 public janitors want to make it more convenient for their spouses to go to work or for their children to go to school.

3.2.2 Commuting time

By counting the number of commuters, i.e., the public janitors, during different commuting time periods, we can see that there is a considerable time difference

between public janitors' rush hour and the general public's rush hour (Fig. 11). The Xi'an Traffic Police Detachment dataset, published in the *Sanqin Metropolis Daily* in 2018, shows that the general morning rush hour is from 7:30 to 8:00, with a peak at 7:50; the evening rush hour is between 17:40 and 19:00, and the peak time is 18:20. However, it is noteworthy that public janitors start work much earlier in the morning. More than 98.24% of the public janitors must be at work before 7:30 when the general public morning rush hour begins (Fig. 11a). However, there are two peaks for the evening rush hour of public janitors. One is between 17:00 and 19:00, which is relatively coincident with the general public evening rush hour. The other peak time is from 21:00 to 23:00 when the bulk of the general public has already been off work for about three hours (Fig. 11b). In short, off-peak commuting greatly reduces the time public janitors spend commuting because off-peak commuting helps them to cut down on time wasted in rush hour traffic.

3.2.3 Sensitivity to commuting distance

Sensitivity to commuting distance is also a critical factor. Increased sensitivity to commuting distance means a greater possibility of living near jobs. Sensitivity to commuting distance can be summarized from the perception of commuting distance. Four kinds of qualitative measurements of distance, namely, very close, close, far, and very far (Table 1) are used to investigate public janitors' perceptions of commuting distance. In

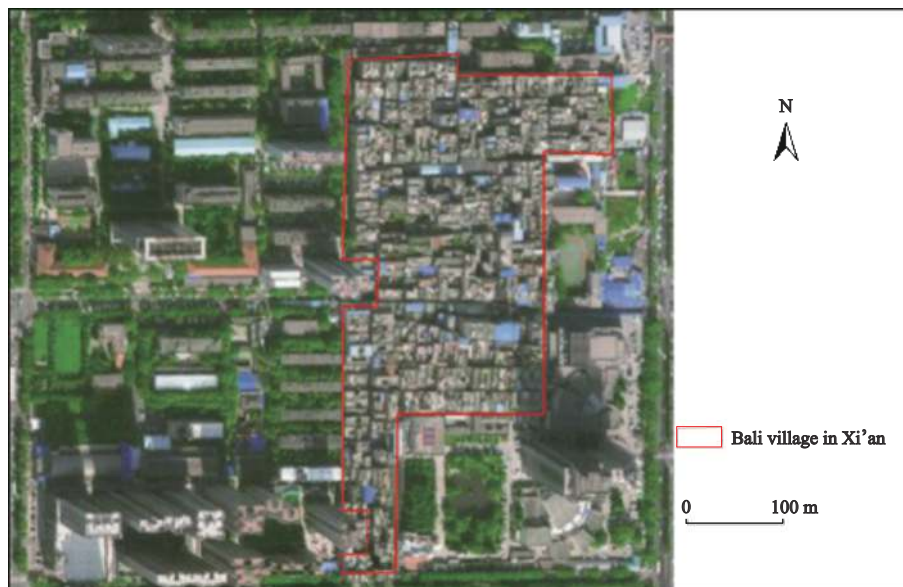


Fig. 10 One of the villages in Xi'an, which is from Baidu Satellite Images

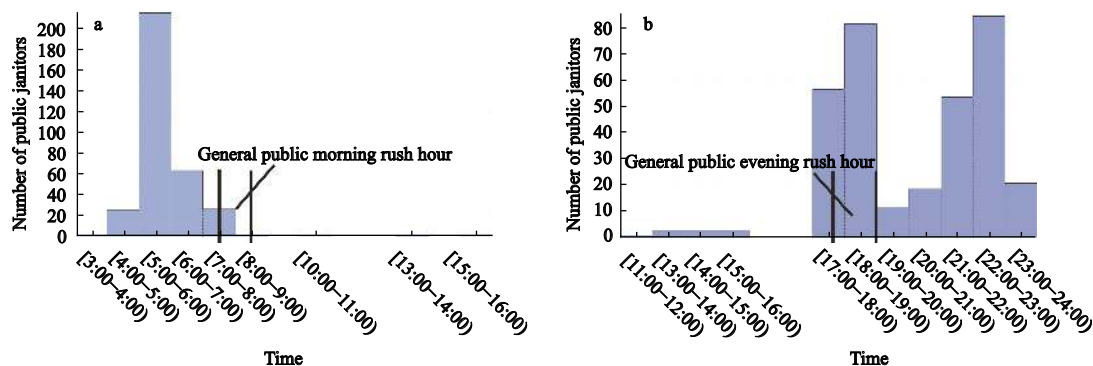


Fig. 11 Histogram of public janitors' (a) morning and (b) evening commuting time

Table 1 The number and proportion of public janitors with different perceptions of commuting distance and the median commuting distance

Perception of commuting distance	Number of public janitors	Proportion of public janitors / %	Median commuting distance / km
Very close	40	11.76	0.88
Close	194	57.06	1.41
Far	83	24.42	2.39
Very far	23	6.76	4.26
Total	340	100	—

the opinions of most public janitors, they live close or even very close to their jobs. It is noteworthy that the number of public janitors who perceive commuting distance differently changes significantly as their actual median commuting distance increases. When the median commuting distance is less than 1.41 km, most public janitors think they live close or very close to their jobs. However, it is only when the commuting distance exceeds 2.39 km that perception of commuting distance of public janitors changed to very far. Therefore, it can be said that public janitors are very sensitive to commuting distance.

The high sensitivity to the commuting distance of public janitors is mainly caused by their high level of non-motorized commuting modes. Most of them walk or cycle to work. This is because public janitors generally have limited access to private cars or public transport due to their low income. Therefore, they are more likely to live close to their jobs.

4 Discussion and Conclusions

4.1 Discussion

The original SMH was conceived in the context of the loss, over time, of low-paid retail jobs in areas close to the inner city. Therefore, the emphasis was on temporal

change. In other words, it compared job access, over time, for a disadvantaged group. For that reason, traditional studies testing this hypothesis often examine temporal changes. Although for economic reasons, the process of removing villages-in-the-city in Xi'an is slow, the villages in Xi'an are disappearing gradually year-on-year, especially in the city center, where land use is increasingly intensified and expensive. Where will public janitors live in the future? Based on the urban land curve theory, it is likely that they will have to find low-rent housing, mainly located in the periphery of Xi'an, far from their workplaces. If this happens, will their jobs-housing spatial mismatch occur and become increasingly serious, as is the case in Beijing and Guangzhou? Their jobs-housing spatial relationship could change from 'spatial-bond' to 'spatial-mismatch'. Therefore, it is meaningful and important to investigate the evolution of the jobs-housing spatial relationship for public janitors as the Xi'an villages are gradually removed.

Additionally, future research needs to examine the underlying reason for the jobs-housing spatial relationship of public janitors: job accessibility. Problems arise when the location separation between workplace and accommodation is too big to be justified (e.g., a better-paid worker may commute longer than a low-wage earner but may not necessarily experience spatial mis-

match). This prompts us to identify whether spatial mismatch happens to this particular low-wage group in specific concentrated areas/locations.

The above findings have important policy implications. More attention should be paid to the reform of government-subsidized housing projects to prevent future spatial mismatch. These initiatives will ensure the rights of poverty-affected local households and the large migrant population (i.e., public janitors). Simultaneously, the government also needs to go further to address the issue of rent subsidies for the migrant poor, who, for many years, have worked as public janitors in Xi'an. They should have more opportunities to rent accommodation near their workplaces. Additionally, efforts are needed to reform the current salary policy for public janitors, such as adding commuting allowances to improve their transportation mobility.

4.2 Conclusions

This research, although exploratory in nature, is one of the few research studies looking into the jobs-housing spatial relationship issue among low-wage workers in the cities of northwestern China. The aim of the research was to test the effectiveness of the SMH for low-wage workers in Chinese cities, and to fill the knowledge gap concerning the underlying factors that may, or may not, result in spatial mismatch. This paper examines the jobs-housing spatial relationship of public janitors in Xi'an, and it provides a detailed exploration of the causes, based on in-depth interviews, questionnaires, and GIS network analysis. The most important finding is that there is no evident jobs-housing spatial mismatch for public janitors in Xi'an. This conclusion reveals that, to some extent, the effectiveness of the SMH may not be applicable to all low-wage workers in Chinese cities.

The jobs-housing spatial bond for public janitors in Xi'an can be implied from the short commuting distances and the short commuting times. According to our investigation, it is not easy for public janitors to change jobs due to the limitations of their knowledge and skills. Therefore, when job locations are stable, the jobs-housing relationship lies in housing choice, commuting time, and manner of commuting. In this study, the fundamental factor is that most public janitors rent accommodation in villages-in-the-city and in the old residential quarters, both options being low-rent and close to their workplaces. Our study shows that the average commut-

ing distance for public janitors who rent in villages-in-the-city and in the old residential quarters is much lower than that of all public janitors. Another important factor is off-peak commuting, which greatly reduces the commuting time of public janitors. What is more, the heightened sensitivity of public janitors to commuting distance is another critical factor. The high sensitivity to the commuting distance of public janitors is mainly caused by their limited access to private cars or to public transport. As is shown in our survey, the proportions of the public janitors walking and cycling are 39.71% and 36.47%, respectively, accounting for 76.18% of the public janitors studied. This means that most public janitors commute by walking and cycling.

References

- Bi L, Fan Y, Gao Met al., 2019. Spatial mismatch, enclave effects and employment outcomes for rural migrant workers: Empirical evidence from Yunnan Province, China. *Habitat International*, 86: 48–60. doi: 10.1016/j.habitatint.2019.02.008
- Cooke T J, Shumway J M, 1991. Developing the spatial mismatch hypothesis: problems of accessibility to employment for low-wage central city labor. *Urban Geography*, 12(4): 310–323. doi: 10.2747/0272-3638.12.4.310
- Covington K L, 2009. Spatial mismatch of the poor: An explanation of recent declines in job isolation. *Journal of Urban Affairs*, 31(5): 559–587. doi: 10.1111/j.1467-9906.2009.00455.x
- National Bureau of Statistics, 2018. Per capita disposable wage income of urban residents: Cumulative value. Available at: <https://data.stats.gov.cn/easyquery.htm?cn=E0105>
- DeRango K, 2001. Can commutes be used to test the spatial mismatch hypothesis? *Urban Studies*, 38(8): 1521–1529. doi: 10.1080/00420980126670
- 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. doi: 10.1016/j.habitatint.2014.06.002
- Gobillon L, Selod H, 2014. Spatial mismatch, poverty, and vulnerable populations. In: Fischer M M and Nijkamp P (eds), *Handbook of Regional Science*. Springer, 93–107. doi: 10.1007/978-3-642-23430-9_7
- Gobillon L, Selod H, Zenou Y, 2007. The mechanisms of spatial mismatch. *Urban Studies*, 44(12): 2401–2427. doi: 10.1080/00420980701540937
- Gottlieb P D, Lentnek B, 2001. Spatial mismatch is not always a central-city problem: an analysis of commuting behavior in Cleveland, Ohio, and its suburbs. *Urban Studies*, 38: 1161–1186. doi: 10.1080/00420980124613
- Hellerstein J K, Neumark D, McInerney M, 2008. Spatial mismatch or racial mismatch? *Journal of Urban Economics*, 64:

- 464–479. doi: 10.1016/j.jue.2008.04.003
- Holzer H J, 1991. The spatial mismatch hypothesis: what has the evidence shown? *Urban Studies*, 28: 105–122. doi: 10.1080/00420989120080071
- Holzer H J, Ihlanfeldt K R, 1996. Spatial factors and the employment of blacks at the firm level. *New England Economic Review*, May/June Special Issue: 65–82. doi: 10.1.1.217.3853
- Hu L, 2015. Job accessibility of the poor in Los Angeles: Has suburbanization affected spatial mismatch? *Journal of the American Planning Association*, 81(1): 30–45. doi: 10.1080/01944363.2015.1042014
- Houston D S, 2001. Spatial barriers to employment within metropolitan areas: testing the spatial mismatch hypothesis using evidence from firm relocations in the Glasgow conurbation. Scotland: University of Glasgow.
- Houston D S, 2005. Methods to test the spatial mismatch hypothesis. *Economic Geography*, 81(4): 407–434. doi: 10.1111/j.1944-8287.2005.tb00281.x
- Hughes M A, Madden J F, 1991. Residential segregation and the economic status of black workers: new evidence for an old debate. *Journal of Urban Economics*, 29: 28–49. doi: 10.1016/0094-1190(91)90024-2
- Ihlanfeldt K R, Sjoquist D L, 1991. The effect of job access on black youth employment: across-sectional analysis. *Urban Studies*, 28: 255–265. doi: 10.1080/00420989120080231
- Ihlanfeldt K R, 1993. Intra-urban job accessibility and Hispanic youth employment rates. *Journal of Urban Economics*, 33(2): 254–271. doi: 10.1006/juec.1993.1016
- Ihlanfeldt K R, 1997. Information on the spatial distribution of job opportunities within metropolitan areas. *Journal of Urban Economics*, 41(2): 218–242. doi: 10.1006/juec.1996.1098
- Ihlanfeldt K R, Sjoquist D L, 1998. The spatial mismatch hypothesis: a review of recent studies and their implications for welfare reform. *Housing Policy Debate*, 9(4): 849–892. doi: 10.1080/10511482.1998.9521321
- Ihlanfeldt K R, Young M V, 1996. The spatial distribution of black employment between the central city and the suburbs. *Economic Inquiry*, 34(4): 693–707. doi: 10.1111/j.1465-7295.1996.tb01405.x
- Immergluck D, 1998. Job proximity and the urban employment problem: do suitable nearby jobs improve neighborhood employment rates? A comment. *Urban Studies*, 35(1): 7–23. doi: 10.1080/0042098985041
- Kain J F, 1968. Housing segregation, Negro employment, and metropolitan decentralization. *Quarterly Journal of Economics*, 82(2): 175–197. doi: 10.2307/1885893
- Kain J F, 1992. The spatial mismatch hypothesis: three decades later. *Housing Policy Debate*, 3(2): 371–460. doi: 10.1080/10511482.1992.9521100
- Li S M, 2010. Evolving residential and employment locations and patterns of commuting under hyper growth: The case of Guangzhou, China. *Urban Studies*, 47(8): 1643–1661. doi: 10.1177/0042098009356118
- McLafferty S, Preston V, 1992. Spatial mismatch and labor market segmentation for African-American and Latina women. *Economic Geography*, 68(4): 406–431. doi: 10.2307/144026
- Preston V, McLafferty S, 1999. Spatial mismatch research in the 1990s: progress and potential. *Paper in Regional Science*, 78(4): 387–402. doi: 10.1007/s101100050033
- Sanchez T, Shen Q, Peng Z R, 2004. Transit mobility, jobs access and low-income labour participation in US metropolitan areas. *Urban Studies*, 41(7): 1313–1331. doi: 10.1080/0042098042000214815
- Stoll M A, 1999. Spatial job search, spatial mismatch, and the employment and wages of racial and ethnic groups in Los Angeles. *Journal of Urban Economics*, 46(1): 129–155. doi: 10.1006/juec.1998.2116
- Taylor D B, Ong P M, 1995. Spatial mismatch or automobile mismatch? An examination of race, residence, and commuting in US metropolitan areas. *Urban Studies*, 32(9): 1453–1473. doi: 10.1080/00420989550012348
- Thompson M A, 1997. The impact of spatial mismatch on female labor force participation. *Economic Development Quarterly*, 11(2): 138–145. doi: 10.1177/089124249701100203
- 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. doi: 10.1016/j.jtrangeo.2008.04.005
- Wang E, Song J, Xu T, 2011. From ‘spatial bond’ to ‘spatial mismatch’: an assessment of changing jobs-housing relationship in Beijing. *Habitat International*, 35(2): 398–409. doi: 10.1016/j.habitatint.2010.11.008
- Zhang C, Man J, 2015. Examining job accessibility of the urban poor by urban metro and bus: a case study of Beijing. *Urban Rail Transit*, 1(4): 183–193. doi: 10.1007/s40864-015-0026-5
- Zhou Jiangping, Chen Xiaojian, Huang Wei et al., 2013. Jobs-housing balance and commute efficiency in cities of central and western China: a case study of Xi’an. *Acta Geographica Sinica*, 68(10): 1316–1330. (in Chinese)
- Zhou S, Liu Y, Kwan M, 2016. Spatial mismatch in post-reform urban China: a case study of a relocated state-owned enterprise in Guangzhou. *Habitat International*, 58: 1–11. doi: 10.1016/j.habitatint.2016.08.003
- Zhu Jing, Dong Xin, He Jianxiong et al., 2015. The commuting characteristics of residents in metropolis in Plain area of western China: a case study of Xi’an, Shaanxi province. *Human Geography*, (3)118–124. (in Chinese)