Research on the Jobs-Housing Relationship in Yinchuan' s Central Urban Area Based on Baidu Heat Maps (Postprint)

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Date: 2019-08-02T00:00:00+00:00

Abstract

"Employment" and "residence" represent the most fundamental functions of a city, with the employment-residence relationship reflecting urban order and efficiency. Based on real-time dynamic big data provided by Baidu heat maps and Baidu traffic maps, combined with current land use maps of the urban area, this study analyzes the employment-residence relationship in Yinchuan' s main urban district. The results demonstrate that during working hours within a workday, population aggregation intensity is greater on educational and commercial land, whereas during rest periods, population aggregation on residential land becomes more pronounced, exhibiting a roughly inverse trend between the two. This indicates that during working hours, large numbers of people depart from residential areas, causing Baidu heat values to decline, while during off-duty hours they return to residential areas, causing Baidu heat values to rise, thereby demonstrating rhythmic pendulum-like mobility among residents between workplaces and residences. Areas with high population concentration during working hours are predominantly workplaces such as business centers, urban complexes, institutions of higher education, hospitals, and logistics centers; during rest periods, centers of high population aggregation shift from employment centers to residential zones and leisure shopping districts, indicating a certain degree of jobs-housing separation throughout the urban area. Yinchuan' s employment-residence ratio ranges from 0.34 to 3.4, suggesting a relatively balanced employment-residence relationship, though with substantial inter-regional variations. Overall, employment-residence balance is more pronounced in central urban areas than in peripheral districts. Based on the employment-residence ratio, the employment-residence relationship is classified into five categories: basic balance type, slight employment bias type, severe employment bias type, slight residence bias type, and severe residence bias type.

Full Text

Preamble

DOI: 10.12118/j.issn.1000-6060.2019.04.24
Journal: Arid Land Geography (ChinaXiv Collaborative Journal)

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1. Data and Methods

1.1 Data Sources

This study utilizes Baidu Heat Map data, Baidu Road Map, and urban land-use maps to analyze the jobs-housing relationship in Yinchuan City' s central urban area. The Baidu Heat Map provides real-time dynamic big data depicting population aggregation patterns. Data were collected across a full day divided into five periods: two commuting periods, two working periods, and one rest period. The Location Based Service (LBS) technology enables precise spatial tracking, with data covering 15 consecutive days in 2017, specifically during peak morning hours (9:00-12:00) and afternoon hours (14:00-18:00). The analysis focuses on identifying spatial-temporal patterns of population concentration and movement between residential and employment centers.

1.2 Data Processing

The data processing was conducted using ArcMap software. Baidu Heat Map data was exported in PNG format with four bands, where band 4 (Alpha channel) contains the actual heat intensity values in 256 grayscale levels. The RGB bands were discarded during processing. Using ArcMap' s reclassification tool, the grayscale values were reclassified into seven categories (1-7), with categories 6-7 representing high-heat zones, categories 4-5 representing medium-heat zones, and lower values representing low-heat zones. The reclassification threshold was set at 14:00-18:00 for working period analysis and 7:00-9:00, 12:00-14:00 for commuting periods.

[FIGURE 1: Analysis framework diagram]

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2. Results and Analysis

The study area covers approximately 400 km^2 of Yinchuan' s central urban district. The analysis reveals distinct spatiotemporal patterns in population

aggregation across different land-use types and time periods.

2.1 Temporal Patterns of Population Aggregation

During the working day, the proportion of high-heat zones increased significantly from 7:49 AM, with the most dramatic rise occurring between 7:49 AM and 9:11 AM, coinciding with morning commute peaks. The heat intensity remained relatively stable from 9:11 AM to 6:15 PM, reflecting normal working hours. From 6:15 PM onward, heat intensity dropped sharply, corresponding to evening commute patterns. After 7:38 PM, heat levels began rising again, indicating the rest period when populations returned to residential areas.

2.2 Land-Use Specific Patterns

During working hours, population concentration was strongest in educational and commercial land uses, including business centers, urban complexes, universities, hospitals, and logistics centers. During rest periods, high-concentration centers shifted from employment zones to residential and leisure shopping areas, indicating a clear spatial separation between work and residential functions in the main urban area.

[FIGURE 3: Heat map of people agglomeration and traffic flow diagram with busy section in 9:11, Yinchuan]

[FIGURE 5: Proportion of high heat/sub-high heat area of each land use of central city in Yinchuan]

2.3 Jobs-Housing Balance Analysis

Based on the jobs-housing ratio (calculated as employment density divided by residential density), the study area was classified into five relationship types: basic balance, slight employment tendency, serious employment tendency, slight residence tendency, and serious residence tendency. The jobs-housing ratio ranged from 0.34 to 3.4 across the study area.

The analysis reveals significant spatial variation: - **Xixia District South Group**: Industrial concentration area with basic jobs-housing balance - **Xixia District North Group**: University concentration area with basic balance - **Jinfeng District South Group & Xingqing District East Group**: Commercial-residential areas with significantly higher residential than employment density - **Xingqing District Northwest Group**: Commercial and trade center (old urban area) with prominent employment concentration

[FIGURE 6: Area proportion of high heat area of each land use of central city in Yinchuan at work and rest periods]

[FIGURE 7: Spatial relationship between high heat area and land-use type of central city in Yinchuan at work and rest periods]

[FIGURE 8: Ratio of jobs-housing in downtown Yinchuan City]

[TABLE 2: Ratio of jobs-housing relationship in Yinchuan City]

The results demonstrate that the central urban area exhibits more pronounced jobs-housing balance than outlying areas, with notable functional differences between districts. The rhythmic pendulum flow between residential and employment areas follows predictable temporal patterns, with Baidu Heat Map data effectively capturing these dynamic relationships.

Abstract: "Job" and "Housing" are the most basic functions of the city, and the relationship between job and housing reflects the order and efficiency of the city. Under the planned economic system of China, under the profound influence of "unit (Danwei) management society" , the relationship between workplace and residence was very well matched. After 1992, with the drastic transformation of urban economy and society in China, the situation of separation between workplace and residence has become increasingly prominent, which has led to a series of housing, commuting, social equity and other issues. Based on the real-time dynamic big data provided by Baidu Heat Map, Baidu Road Map and the urban land-use map, this paper analyzes the relationship between job and housing in the main urban area of Yinchuan City, Ningxia Province, China. The whole day is divided into five periods (two commuting periods, two working periods and one rest period). The Baidu Heat Map in different periods and for different land use are obtained to depict the population aggregation situation in the main urban area. The results showed that: During the working day, the proportion of the high-heat zones was increased significantly from 7:49 AM, especially in the period from 7:49 AM to 9:11 AM, which was closely related to the peak commutes, and then fluctuated upwards, but was basically stable from 9:11 AM to 6:15 PM, which was consistent with the normal working hours. Starting from 6:15 PM, it was dropped sharply, which was commensurate with commuting peak. After 7:38 PM, it started to go up again, and this was a rest period. During the working hours, the population concentration on the educational and commercial lands was stronger, while during the rest period, the population concentration on the residential land is more obvious. Baidu Heat declined when a large number of people left the residential area during the working hours, and rose when they returned to the residential area during the off-duty hours, which means that there is a rhythmic pendulum flow between residential areas in the workplace. Residents in the working hours are highly concentrated in business centers, urban complexes, universities, hospitals and logistics centers, etc. During the rest period, the high concentration centers of the population changed from employment centers to residential areas and leisure shopping areas, indicating that there is a certain separation of work and residential areas in the main urban area. According to the ratio of occupation and housing, the relationship between employment and housing is divided into five types: basic balance type, slight employment tendency, serious employment tendency, slight inhabitation tendency and serious residence tendency. Generally speaking, the balance of job and housing in urban central area is more

obvious than that in the outlying areas, and there are great differences between functional groups. The south group of Xixia District is an industrial concentrated distribution area, the north is a university concentrated distribution area, so there was a basic balance of residential and employment; the south group of Jinfeng District and the east group of Xingqing District exist a large number of commercial residential areas where living is significantly higher than employment; the northwest group of Xingqing District is the commercial and trade center and so is the old urban area of Yinchuan City, where the employment is more prominent.

Keywords: Baidu Heat Map; jobs-housing relationship; central city; Yinchuan City

Note: Figure translations are in progress. See original paper for figures.