Exploring the Impacts of Railway Station Accessibility on Property Value: A Case Study of Beijing

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ABSTRACT

Living in the urban area or close to a transit hub is expensive in Beijing. Urban built environment could provide more high-quality amenities and more job opportunities; while public transit hub benefits people with better access to each part of the city. Therefore, this research selected five primary railway stations in Beijing to explore the railway station accessibility on property value. Since these five stations have a different built environment in the proximity, whether the urban environment has a relationship with the impacts of accessibility is uncertain.

By using the hedonic model in quantitative analysis, this research could answer the questions. The primary findings are: (1) Within a certain radius, the railway stations have an overall positive impact of raising the property values. Generally, the impacts are maximum when the radius is 1.16 km. (2) Suburban and urban built environment play an important role in determining the impacts of railway station accessibility. If a property is in the suburb, it will be much cheaper because of the under-developed built environment. (3) More commercial activities and job opportunities in the railway station area could raise property values.

From the aspect of urban planning, this research comes up with several strategies for station planning: (1) Promote mixed-use development and transit-oriented development in the suburban railway station project to increase mobility. (2) Create a transaction management platform to increase the supply of affordable housing in the station area. (3) Implement a feedback loop among stakeholders and introduce more investment to enhance local economic development.

KEY WORDS: Railway Station Accessibility, The Hedonic Model, Property Value, Built Environment, Interaction

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CONTENTS

ABSTRACT

ACKNOWLEDGEMENTS

CONTENTS

LIST OF ABBREVIATION

CHAPTER 1 INTRODUCTION

- **1.1. Context**
- **1.2. Research Questions**
- **1.3. Roadmap**

CHAPTER 2 BACKGROUND

- **2.1. Beijing's Primary Railway Stations: The Important Transit Node**
- **2.2. Housing Market: Expensive Properties near Stations**

CHAPTER 3 LITERATURE REVIEW

- **3.1. Public Transit and Commuting**
- **3.2. Accessibility to Rapid Transit and Property Value**
- **3.3. Theory of Hedonic Model**

CHAPTER 4 DATA DESCRIPTION

- **4.1. Data Source**
- **4.2. Measuring Accessibility and Its Impacts**

CHAPTER 5 METHODOLOGY: HEDONIC MODEL

- **5.1. Data Pre-processing**
- **5.2. The Specification of the Hedonic Model**
- **5.3. Model Results**

CHAPTER 6 ANALYSIS: ACCESSIBILITY AND BUILT-ENVIRONMENT

6.1. Impacts of Railway Station Accessibility

6.2. Considering the Urban or Suburban Built Environment

6.3. Impacts of Other Factors in Hedonic Model

6.4. Amenities Density Analysis

CHAPTER 7 CONCLUSIONS AND LIMITATIONS

7.1. Conclusions

7.2. Limitations

CHAPTER 8 RECOMMENDATIONS FOR PLANNING

8.1. Regional Planning for Job-housing Balance

8.2. Residential Planning in Railway Station's Area

APPENDIX

REFERENCE

LIST OF ABBREVIATION

CNY: The Chinese Yuan Renminbi presents the currency of China. 1 CNY generally equals to 0.15 United State Dollars.

Beijing Station: Beijing Railway Station

South Station: Beijing South High-speed Railway Station

West Station: Beijing West Railway Station

North Station: Beijing North Railway Station

Vice Center Station: Beijing Vice Center Station

Radius: A radius of impacts, in which the railway station would have a specific impact on the property value

CHAPTER 1: INTRODUCTION

1.1. Context

In a megacity, the properties near the transit hub are always attractive but expensive because of the accessibility to the working places and the other part of the city, so it is in Beijing.

When people decide to buy a property in Beijing, factors such as property value, built environment and the accessibility to a transit hub are playing an essential role. Contemporary Beijing is suffering lots of severe "big city diseases." Typically, "lack of affordable housing" and "long commuting times" are becoming the key issues contributing to a situation of "job-housing separation." This separation is reflected in that massive people are living far away from their working places. In this scenario, living near a transit hub is becoming more desirable for the people who need long-time commute by public transit. All transit hubs have multiple modes of public transit. Beijing has developed a highly sophisticated public transit network, which is enabling people to rely more on public transit modes.

Beijing has lots of transit hubs in different types. These transit hubs are mainly the railway stations and subway interchange stations. Among these transit hubs, only railway stations serve for both inner-city and inter-city commuting, which might significantly raise the property value. But at the same time, railway stations are usually noisy and crowded, which might devaluate the property. Beijing has plenty of railway stations in both urban and suburban areas. The primary railway stations in urban Beijing are **Beijing Station**, **South Station**, **North Station** and **West Station**; while in suburban Beijing, the government has proposed to build a new railway station named **Vice Center Station** to improve the mobility. The built environment in urban and suburban areas are much different and might different impacts on property value. For instance,

the urban built environment provides more high-quality amenities, and suburban built environment is rich in green spaces.

From the aspect of urban planning, understanding how railway stations impact the property value could promote social equity and boost local economic development. Even though there are lots of related studies conducted in Beijing, most of them focused on the urban railway station. Therefore, this research aims to explore the relationship between all types of the railway station and the property value, by taking the built environment into consideration.

1.2.Research Questions

"Railway station accessibility" and "property value" are the key words in this research. In the context of urban planning, this research needs to identify two relationships: the spatial relationship between the railway station accessibility and property value; the correlation between the built environment and the accessibility's impacts on property value. By applying quantitative methodology, this research aims to answer two primary questions:

(1) Keeping the other factors equal, how could the railway station accessibility impact the property value?
(2) How much are the impacts of accessibility on property value different for the urban and suburban areas?

In order to apply a quantitative methodology to calculate the relationship, this research comes up with two hypotheses. These hypotheses ensure this research could be conducted with achievable goals.

(1) Railway station accessibility could raise property value within a certain radius. If measured by accessibility, the properties with the most accessibility don't have the highest price because of the other factors. In other word, the spatial relationship between accessibility and property value is not liner.

(2) The impacts of accessibility on property value would be different for an urban railway station and a suburban railway station. If keeping the other factors unchanged, an urban railway station could raise more property values than a suburban station.

Therefore, by quantitative analysis and answering two research questions, this research expects to achieve three goals:

(1) Provide an empirical case study of exploring the relationship between railway station accessibility and property value. By the results, readers could understand the mechanism and impacts of different levels of accessibility.

(2) Identify the different impacts for an urban railway station and suburban railway station. Then, find out the key elements determining the differences.

(3) Finally, this research could come up with some specific strategies to promote social equity and release housing pressure, from the aspect of residential planning and transit-oriented development.

1.3.Roadmap

For a better representation of research components, the main body of this research would be organized as follows:

CHAPTER 1 presents the general introduction about the research, including the context and research statement.

CHAPTER 2 gives detailed information in the context. Related background to this research includes the introduction of primary railway stations in Beijing; the importance of these railway stations as a transit hub and their contribution to improving mobility; and the contemporary housing market in Beijing and near a railway station.

CHAPTER 3 reviews the literature which are under relevant topics of the research questions. This chapter mainly introduces the empirical case studies of exploring the relationship between the transit hub and the property value, primarily focusing on the railway station.

CHAPTER 4 describes the data sources used in quantitative analysis and decides the measurement of accessibility and impacts.

CHAPTER 5 is methodology. This research uses the hedonic model for quantitative analysis to explore the relationship between railway station accessibility and property value. Also, this chapter answers the questions of different impacts for different types of railway stations.

CHAPTER 6 serves as a supplementary analysis of the hedonic model. This chapter lays out the potential environmental elements showing the difference between urban and suburban area.

CHAPTER 7 contains conclusions and limitations. This chapter would re-cap the research introduction, summarize the findings, and list the research's limitations.

CHAPTER 8 comes up with specific recommendations from the aspect of residential development and transit-oriented development.

CHAPTER 2: BACKGROUND

2.1. Beijing's Primary Railway Stations: The Important Transit Node

So far, Beijing has developed a complex public transit network which links each part of the city and counteracts the locational inconvenience in suburban areas. This public transit network consists of subway stations and railway stations. As shown in Fig.1, subway stations (the orange dots) and railway stations (the purple and red dots) are distributed unevenly across Beijing. Usually, people will consider the fifth ring-road (the grey stripe) as the boundary of urban and suburban Beijing. Therefore, most public transit stations, especially subway stations, are concentrated in urban areas. However, in the suburban area, there are more railway stations and fewer subway stations. Typically, the subway stations and the railway stations are distributed along the primary road, which indicates they are essential geographical locations.

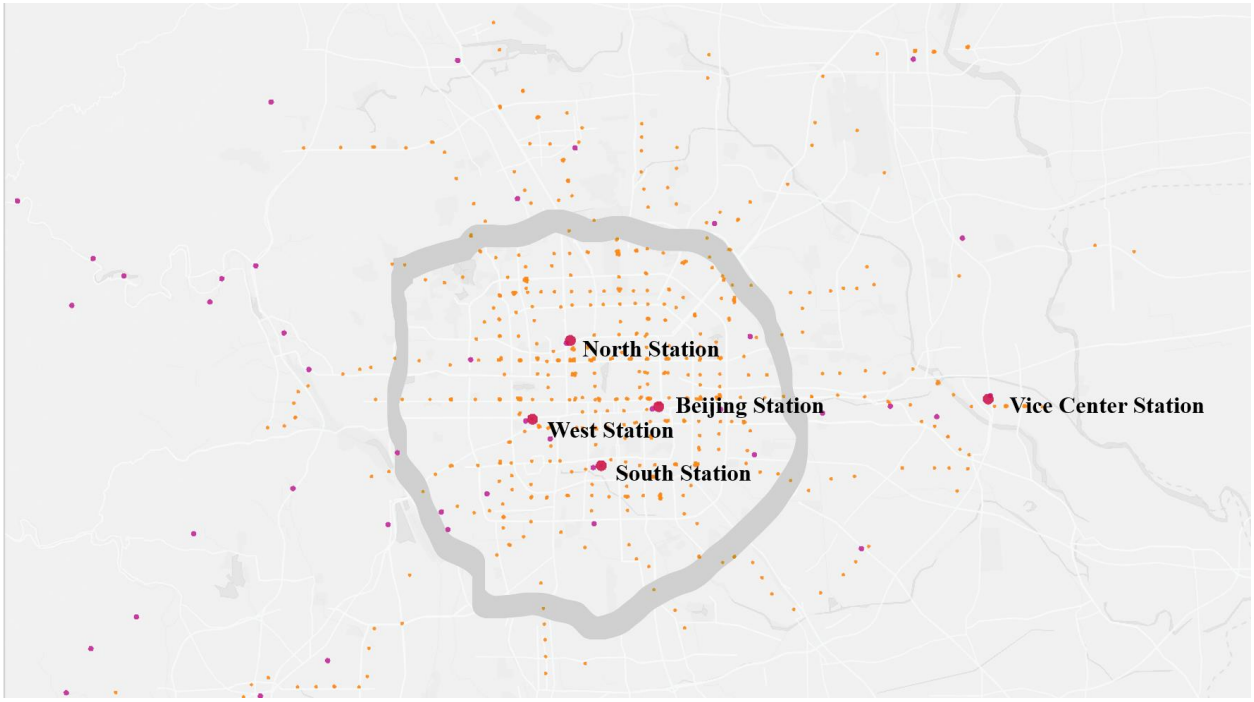


Fig.1. The Distribution of Public Transit Stations in Beijing

Under this public transit system, people could take the train and subway for daily commuting. Subway stations are primarily responsible for passenger transit and serve for inner-city commuting. Railway stations could serve for both inner-city and inter-city transit for passengers and freights. While some railway stations are famous for their high passenger flow, most railway stations in Beijing are freight stations. Typically, there are several primary railway stations are offering services both for freight and passenger transit. They are four urban railway stations: **Beijing Station**, **South Station**, **North Station**, **West Station** and one proposed suburban railway station: **Vice Center Station**.

Since built environment near a railway station is very different for the urban and suburban area, therefore some environmental factors such as the types of land use and the mixed-use development might have impacts on the property value. The following figures are showing a comparison of built environment of each railway station.

2.1.1. Beijing Station

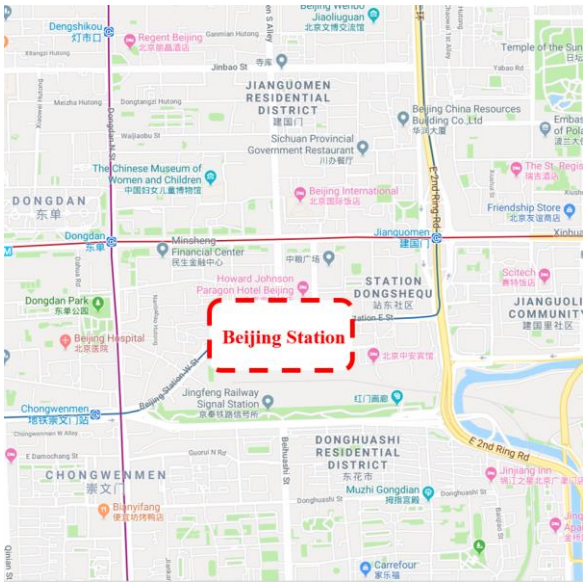
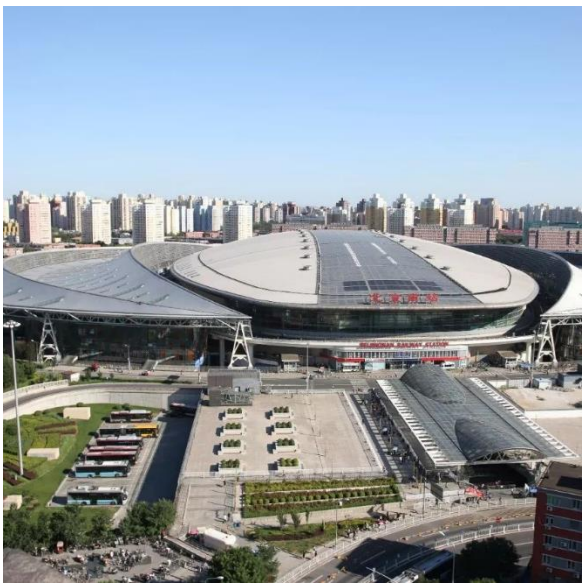


Fig.2. The Current Built Environment near Beijing Station

Beijing Station is located near the city core, which was the largest railway station in Beijing. Since it first opened in the year of 1959, it has been developed into a primary railway station serving both national and international lines. Later, this station joined the subway system and became a stop on Line Two. After several decades, Beijing Station is not only one of the landmarks of Beijing, but a major transit hub as well ("Beijing railway station," 2019). According to Fig.2, the built environment around Beijing Station is of the typical urban landscape: fewer green spaces, well-organized road network, more amenities, and high-density land use.

2.1.2. South Station



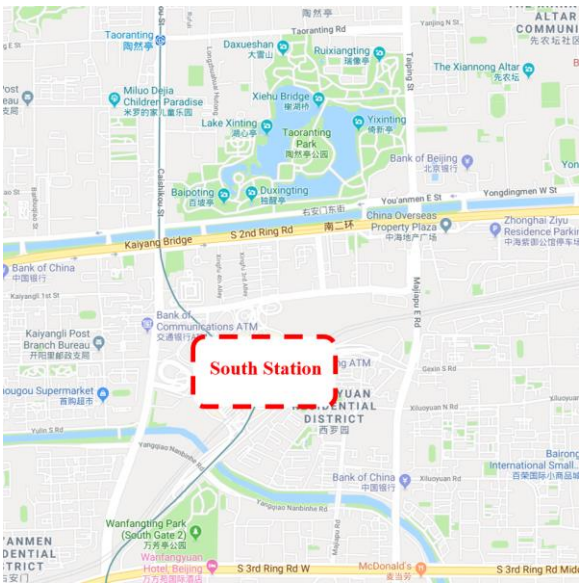


Fig.3. The Current Built Environment near South Station

South Station is located in the southern part of the city, on the edge of urban Beijing. This station is currently the largest railway station in Asia and mainly serves for high-speed railway.

As Beijing Station, South Station also joined the subway system and integrates two subway stations (“Beijing South railway station,” 2019). From Fig.3., the built environment near South Station is partially different from Beijing Station. It has more green spaces and less major roads in the area. However, since it is in the urban area, the buildings are still compact and in a high density.

2.1.3. North Station

Fig.4. The Current Built Environment near North Station

North Station is located in the northern part of the city core. It is one of the oldest railway stations in Beijing. Since another interchange subway station is located just outside North Station, so this research considers two stations as a whole. In this scenario, North Station is connected to three subway lines. At the end of 2019, this station would finish the renovation project and serve high-speed railway to connect the region (“Beijing North railway station,” 2019). Even next to the city center, the built environment near North Station is much better in

terms of green spaces and recreational sites. As the other part of the city, it has massive mixed land use and well-connected road network.

2.1.4. West Station

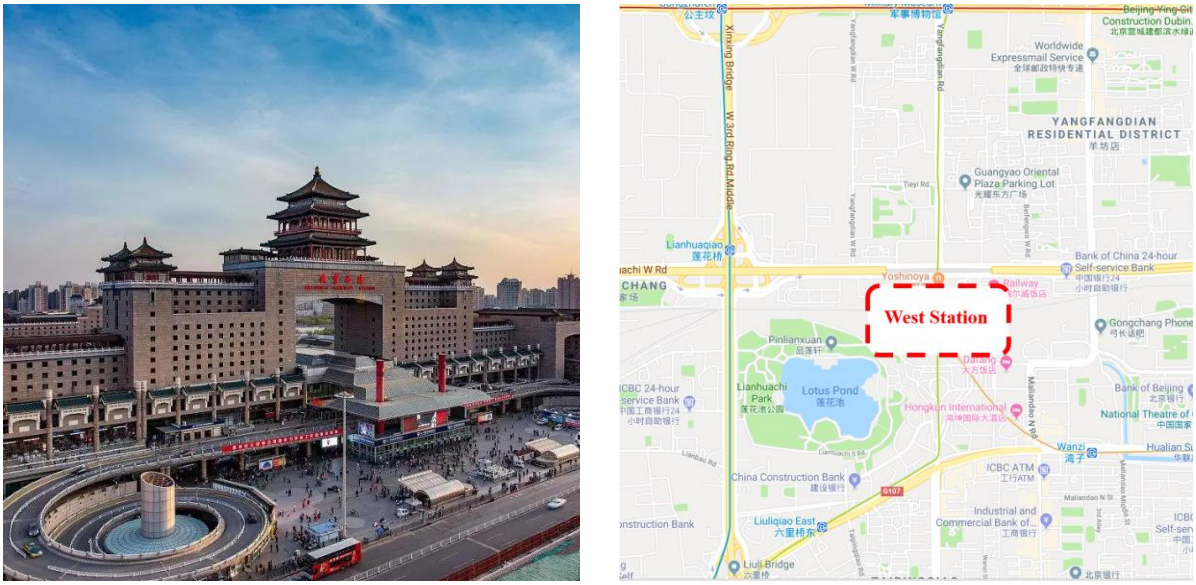


Fig.5. The Current Built Environment near West Station

West Station is located in the western part of the city. It was ever the biggest railway station in Asia till South Station came into service. The main idea of building West Station was to release the passenger pressure in Beijing Station. This station is the terminals for both traditional trains and high-speed rails. Moreover, this station is connected to two subway lines. Now, except for North Station in the urban area, Beijing Station, West Station, and South Stations are three main passenger rail transit hubs in China (“Beijing West railway station,” 2019). Shown in Fig.5.m higher traffic volume and diverse land use are the characteristics of this station area, similar to the other urban stations.

2.1.5. Vice Center Station

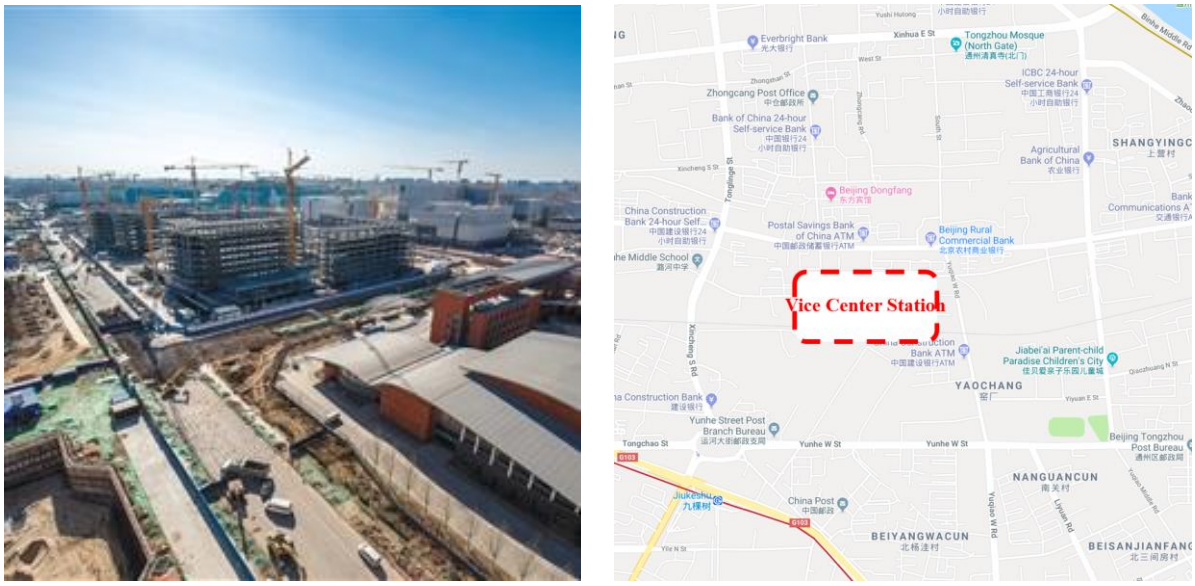


Fig.6. The Current Built Environment near Vice Center Station (Under Construction)

Vice Center Station is in the new subcenter, from the idea of solving "big city diseases" in Beijing. As mentioned in the previous section, the lack of affordable housing and longer commuting time is severe in Beijing. Therefore, to help address these problems, Beijing learned lessons from the other international megacities – building a new subcenter in the suburb. The new subcenter is located in Tongzhou District, aiming to alleviate the population related pressure on Beijing. Moreover, to more reasonably and scientifically transfer people from the urban core, plenty of administrative agencies, educational institutions, and large state-owned enterprises will gradually move to this subcenter (Zheng & Wang, 2015). According to the Beijing Vice Center Regulation Plan, Beijing's new subcenter aims to develop into an urban area without any "city diseases." This goal indicates that in the sub-center, there will be more job opportunities and affordable housing; for people who are working in the other part of Beijing, they will have shorter commuting time; people will have better accessibility to the urban core through public transit (Dong, 2019). In the regulation plan, Vice Center Station is proposed to improve mobility

and promote the development in this new subcenter. This station is proposed to have two subway stops and several inter-city lines ("Beijing Cheng Shi Fu Zhong Xin Zhan," 2019). In the future, Vice Center Station will play an essential role in the public transit network. As shown in Fig.6, the current station area is highly underdeveloped. Since it is in the suburb, there are fewer major roads nearby and amenities with low density.

2.2. Housing Market: Expensive Properties near Stations

Living next to Beijing's transit station is always higher. Contemporary Beijing is now facing lots of challenges such as lacking affordable housing and longer commuting times (China.org.cn, 2019). As mentioned in the previous section, the stresses of "longer commuting time" could be partially solved by Beijing's public transit network. However, the issue of "lacking affordable housing" is more affected by the housing market.

2.2.1. Housing Market in Beijing

Beijing's housing market is probably the most expensive in the world. Huge populations with lower income and traditional Chinese ideas contribute to higher property values in Beijing.

People can't afford to buy a property in Beijing because of their lower income. Plenty of reports such as "China Residential Housing Market Development Monthly Analytical Report" have concluded that Beijing has the highest median property value amongst one-tier cities in China (China Banking News, 2018). Indeed, living and housing burden in Beijing is far heavier than anywhere else in China. Based on NUMBEO statistics (https://www.numbeo.com/property-investment/in/Beijing) of the property price, property value to income ratio in Beijing is more than four times than in New York. At the same time, buying an apartment in the urban area

(which is 103,465.73 CNY per square meter) could cost twice as much as buying outside the urban core (which is 51,646.38 CNY per square meter). However, the average annual net salary is 97,471.92 CNY, which means most people working in Beijing couldn't afford to buy an apartment in Beijing, neither in the urban nor suburban area.

Besides the lower income, the growing population makes this competition crueler. As the political and cultural center of China, Beijing has developed into one of the largest and most populous cities in the world. It continuously attracts people and investment by providing more employment opportunities and diverse lifestyles. A large number of people are pouring into this city and significantly exacerbate the low living capacity in urban areas; therefore urban sprawl happened. This geographical extension brings more housing and working opportunities for Beijing. Most opportunities are emerging in the suburban areas. A previous study has found that Beijing is undergoing a rapid urban sprawl, and this stretched urban form is characterized by a longer distance between working and living (Ding, Zheng, & Guo, 2010). Even though Beijing has implemented lots of regulations to reduce the imbalance of amenities and development, the suburb is still highly underdeveloped. While the urban area only covers a small proportion of the whole city, the urban environment could provide people with more convenience in daily life. Some people are willing to pay more for living next to high-density and high-quality amenities. Therefore, living in an urban area is always expensive.

Because of insufficient affordable housing in urban Beijing, renting an apartment seems like a better choice for people working in Beijing. A report in the year of 2015 found that there are more than half of the population renting the relatively cheaper apartments in the suburban areas, far away from where they are working (Wong, 2015).

However, Beijing's housing market would keep prosperous all the time because of traditional ideas. Even though the lack of affordable housing gradually pushes people to rent in Beijing, people ultimately would buy their properties. In traditional Chinese ideas, owning a property is an essential task in life, as important as getting married and having a career.

2.2.2. Living next to The Railway Stations

Properties next to the urban core and transit hub are particularly expensive. People always tend to live next to the working places and get more accessibility to higher quality amenities. This competition for better accessibility is always happened near the transit hubs and raises property value significantly. Therefore, residential areas with better accessibility typically command higher property values.

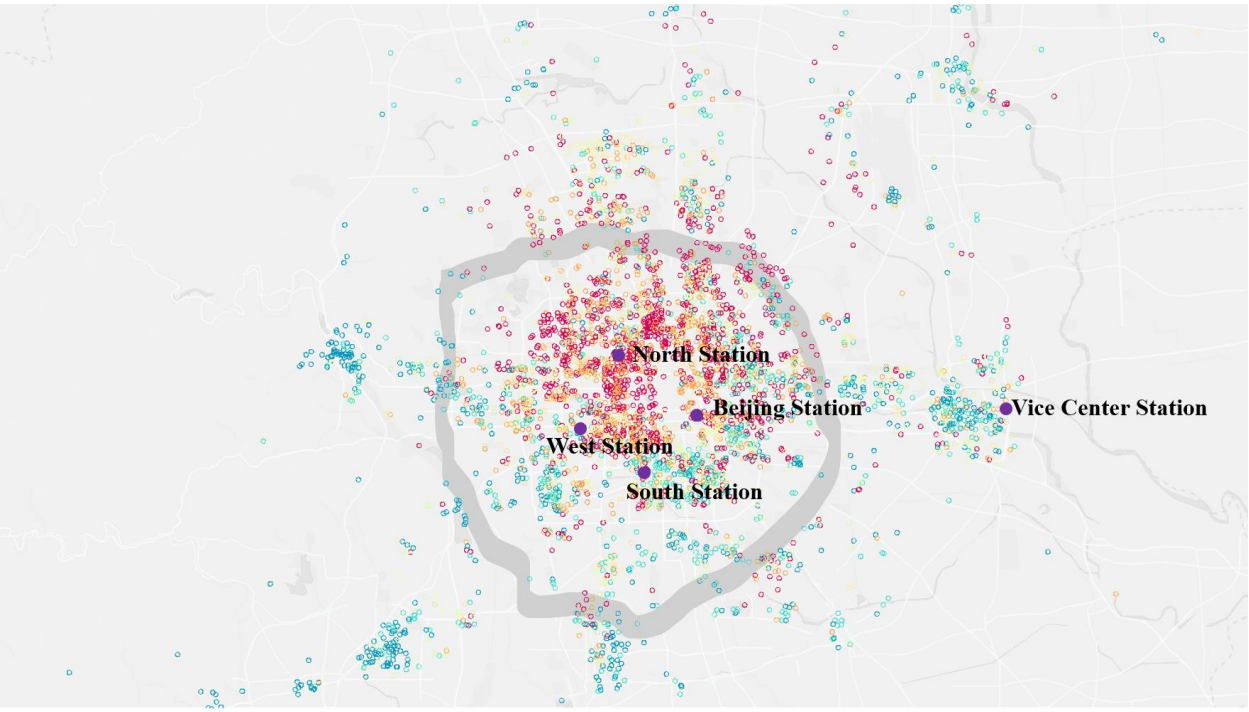


Fig.7. The Distribution of Property Values in 2018

Based on the distribution map of property transaction records in the year of 2018 (Fig.7.), it is evident that the properties in the suburban areas are cheaper (the blue dots) and in the urban areas are more expensive (the red dots). From Fig.7., it seems like the properties next the stations have higher values. But we couldn't conclude only from the maps. Living in a walking distance to a railway station means better access to public transit. As an essential transit node, a railway station not only saves commuting time and provides a sustainable living style to individuals but brings lots of economic benefits to developers. Because of this locational advantage, properties near a railway station is theoretically expensive.

However, the locational factor of the accessibility to a railway station will not wholly explain the property value. The other factors could also have impacts on property value such as the interior characteristics of the property, environmental characteristics in the neighborhood and the other locational characteristics such as the location of the neighborhood.

Therefore, this research expects to use a quantitative method to explore the precise spatial relationship between railway station accessibility and property value.

CHAPTER 3: LITERATURE REVIEW

Before digging into exploring the impacts of railway station accessibility on property value, some previous studies and related information are needed to lay a solid theoretical foundation for the later study. Since there's plenty of relevant studies conducted, to clearly deal with the complex body of the literature, the review would be divided into four main parts. This chapter would cover some important theories relevant to the research hypotheses, historical or current empirical literature which provides methodological contribution and significant findings to the topic.

3.1. Public Transit and Job-housing Relationship

There have been massive studies showing how railway transit has impacts on the commute patterns and the job-housing distribution in the city.

It has been a long time that the concept of "job-housing balance" became a noteworthy planning topic. Generally, "job-housing balance" is a particular state of equilibrium in which people are living closely next to their working places. Also, this balance concept is recognized as the optimal solution to urban diseases, including pollution and congestion. Since the balanced pattern derived from the desire that keeping the prosperous downtown economy and aimed to release the traffic issues; therefore, in the past, the policy directly encouraged this development pattern. In this way, there was less accessibility for the suburban poor to work in the urban core (Giuliano, 1991).

However, by extensive development of diverse transit modes and the transit network becomes more complex, there is a tendency to switch job-housing relationship from "balanced" to "imbalanced," which is "job-housing separation." In this imbalanced situation, the reasons why housing and working places are not linked together would not be limited into ethnical segregation, the other potential commute modes across different commuter groups make a difference (Horner & Mefford, 2007).

On the one hand, the separation is from social inequity and environmental injustice. In this aspect, the imbalanced pattern could be considered under the concept of "spatial mismatch hypothesis," which was proposed by John Kain (Kain, 1968). The hypothesis indicates that since the racial housing segregation, some groups of people have to live far from the working places in the urban area. Therefore, the segregated housing places are distinctly away from the larger

employment centers. For instance, according to the study (Welch, 2013) conducted in Baltimore, though residential from all races and income level groups would expect to live in the transit station proximity, higher rent fee and property values make the property close to the transit hub less attractive. Therefore, low-income households are mainly located away from high-quality transit services and have fewer opportunities for a rapid commute. Also, the study indicates that plotting the job-housing distribution with the public transit network could help to adjust the policy which aims to provide equal transit opportunities to all groups of the people. This spatial mismatch demonstrates that equity and environmental justice are always focuses on the job-housing issue.

On the other hand, the separation comes from extended commuting techniques (Ma & Banister, 2006). As demonstrated in Seoul's case study, physical planning and policy decisions could decrease the commuting time significantly by adding rapid transit investment and upgrading transit infrastructure. It is evident that more rapid transit modes intensify the job-housing separation. At the same time, quantitative imbalance of working and qualitative imbalance of housing contribute to an extensive rail transit development. However, this study argued that rapid transit could partially solve the commuting problem, but it would be more sustainable to link housing and working places close, either in the urban or suburban area. Since the formation of the commute pattern is a long-term process, it is better to understand people's socio-economic characteristics and travel habits before planning.

The disbalance doesn't merely happen in the developed world. Typically, a study based on Chinese cities (Zhang, Xia, & Song, 2017) also reveals a job-housing separation in the city associated with the rail transit and a gradually increasing job-housing re-distribution. Contrast with the US cities where rapid rail transit mainly is provided to the urban poor, rail transit in

Chinese cities is broadly serving as a primary commuting tool for the mid- and low-income suburban people. The job-housing distribution has a particular pattern: housing places are more likely concentrated in the transit hub area and along the rail transit lines; the working places are located in the urban core and separated from the housing area. For Chinese cities, for example, Beijing, the primary reason contributing to the disbalance is the change of the commuting pattern (Wang, Song, & Xu, 2011). “Spatial mismatch hypothesis” in the Chinese context has another interpretation, contrary to the one in the developed world. Two crucial findings in the study need to be noticed. Firstly, the commuting distance has a positive correlation with income level; secondly, the commuting time has no apparent relationship with the income level. Since rapid transit is cheaper than driving and more convenient than riding a bicycle, it is reasonable for mid- and low-income people to choose rapid railway transit and bus. In this scenario, all modes of rapid transit including railway transit and bus largely counteract the job-housing separation. However, in some cities like Tainan (Andersson, Shyr, & Fu, 2010), higher tickets could prevent mid- and low-income people to choose a feasible daily commuting mode between different regions.

In sum, the relevant literature manifests that either in developed countries or in developing countries, a tendency of “job-housing separation” is increasing. At the same time, “Spatial mismatch hypothesis” in China is not from the racial segregation, but an extended commuting technique. In Beijing, the literature has proved that diverse public commuting modes minimize commute time and offset commute distance.

3.2. Accessibility to Rapid Transit and Property Value

At the same time, a rich literature has examined the relationship between the accessibility to a rapid transit station and the spatial distribution of the property value. This section demonstrates four popular modes of rapid transit, including intercity express, subway, light-rail, and bus rapid transit.

3.2.1 Accessibility to a Railway Station

Whether the railway station accessibility impacts, the property value has been investigated in the majority of the property value studies. Indeed, on the one hand, the residents who live next to a railway station could enjoy more travel convenience (Gibbons & Machin, 2005) and an emerging transit-oriented-development model improves the life quality in the station area (Cervero & Murakami, 2009); but on the other hand, the residents might be suffering from noise and pollution (Andersson, Jonsson, & Ögren, 2010). This section would present the empirical literature linking the accessibility to a railway station to the property value.

One of the crucial hypotheses behind the relevant studies is residents who live near a railway station choose to walk there (Gibbons & Machin, 2005; Geng, Bao, & Liang, 2015; Armstrong & Rodríguez, 2006). Within an acceptable walking distance, these studies all found that the accessibility to a railway station could increase the property value. The case study of London (Gibbons & Machin, 2005) concluded that the reduction of commuting time plays a crucial role in buying a property. By conducting the hedonic model, they estimated that each 1 km reduction in distance to the railway station could increase property value by roughly 1.5 percent, keeping the other variables constant. Therefore, the accessibility to the railway station is an essential location-related factor in determining the property value. A case study of Beijing South Railway Station in the year of 2015 (Geng, Bao, & Liang, 2015) indicated that spatial variations exist in

property values combining with the negative and positive effects. Under this overall interaction, the spatial distribution of property values would follow a pattern. The study also applied the hedonic regression model and found the station has a specific impact on property values within a roughly 11 km radius from the station. Property value increases when the distance between property and the station is from 0.475 km to 0.891 km, decreases when the range is from 0.891 km to 1.364 km, and the radius effect gradually diminishes when the range is more than 1.364 km till 11.704 km. In addition to the London and Beijing case study, an empirical study of the hedonic regression model in Eastern Massachusetts (Armstrong & Rodríguez, 2006) also showed a consistent conclusion that the proximity to railway has a significant effect on the property values. They found the single-family property are more likely to pay the accessibility benefits to the railway. In sum, when a property is located near a railway, it could have a higher value, with the other variances equal. Therefore, they believed the establishment of the railway station and the other public transportation infrastructure should remain a priority for the planners and governors.

At the same time, there are some comparison case studies conducted to show consistent results such as one site analysis (Pan, Pan, Zhang, & Zhong, 2014). This comparison consisted of two countries, the United States and China. After applying an ordinary linear regression model and multi-level regression techniques separately, they found the overall effects of the railway on property values are much positive. Although the overall impact of a railway is complicated and combined, notable variations of railway effects are shown at different distance and time range.

However, some studies still found that accessibility shows a minor impact on property value, such as the case study in Tainan city (Andersson, Shyr, & Fu, 2010). In the study, the authors applied the pre-specified and Box-Cox hedonic regression model to analyze the impacts of the

high-speed railway on the local residential property market. The outcomes showed that even though the railway commute might attract more commercial activities to pay more in the station proximity, it has fewer substantial impacts on property value.

3.2.2 Accessibility to a Subway Station

Like the other important urban rapid transit mode, subway accessibility proves the anticipatory impacts on property values again. Unlike the construction of the railway station, the subway station is a relevant short-term project. Therefore, it is possible to analyze the time effect, without taking price fluctuation factor into consideration. So far, there're plenty of empirical studies focused on the time effect (Lin & Hwang, 2004; Bae, Jun, & Park, 2003), which is comparing the property value before and after the subway opening.

A comparison study in Taipei (Lin & Hwang, 2004) reached a conclusion that the construction of subway station could significantly increase the positive hedonic price of floor space and decrease the negative hedonic price of building age and distance to the nearest facility. The authors suggested the policymakers and the developers refer to this variance for future site planning and real estate investment. Other than merely considering station accessibility, another case study of the subway in Seoul subway Line 5 (Bae, Jun, & Park, 2003) integrated more facility accessibility when using hedonic model. Though the opening of the station could increase the accessibility to the other part of the city, the hedonic model results only showed that the accessibility to the station had a statistical effect on housing prices before the line is opening. There is another critical finding from the study since Seoul has a high density of subway network, the subway accessibility has fewer impacts on property value than the other factors

such as the property area, the quality of the school district, and the distance to the central business district.

3.2.3 Accessibility to the Other Rapid Transit Mode

Except for the traditional railway and high-speed railway station, many other rapid rail transit stations also show a similar result. The other types of rapid transit modes, including rapid bus transit and light-rail (Al-Mosaind, Dueker, & Strathman, 1993; Rodriguez & Targa, 2004), could also have an overall positive impact on the nearest property value.

According to a study of exploring the relationship between the light-rail station and the property values (Al-Mosaind, Dueker, & Strathman, 1993), hedonic regression model also indicated that the proximity to light-rail station may improve the accessibility of citizens to central business districts and the rest of the urban areas, therefore, the accessibility could be positively capitalized in property values. A study of bus rapid transit (Rodriguez & Targa, 2004) in Bogota suggested that as an efficient mode of transportation to enhance the urban mobility, the accessibility of bus rapid transit station plays a crucial role in rising rental prices near the station. By estimating a spatial hedonic regression model, they concluded that for every 5 minutes of additional walking to the station could decrease the property values between 6.8 and 9.3 percent, with the other variations equal. Also, the average walking time to the station could translate into an elasticity ranging from -0.16 to 0.22, which indicated another way to interpret the relationship between the accessibility and the property value.

In sum, most studies concluded that accessibility is one of the primary keys to affect property value. The accessibility to rapid transit could have both positive and negative impacts on the property value, and the overall effect would be positive within a certain accessibility radius

distance. However, the accessibility of accessibility radius would differ depending on the geographical location and the type of rapid transit. Also, the built environment is also an essential determinant of property value. The accessibility to diverse amenities and the socio-economic characteristics around the property could also make a difference.

3.3. Hedonic Model Theory

As mentioned in the previous literature review sections, a hedonic model is widely applied in analyzing the relationship between accessibility and property value. Therefore, this study would conduct the hedonic model as well in the next two chapters. Before applying the model, it's necessary to have an understanding of the hedonic model theory. Based on an overview of the hedonic model (Xiao, 2017), this technique has two advantages over the other methodologies: the first one is it could integrate massive property's attributes into one dimension, generally including structural attributes, environmental attributes, and locational attributes; the other one is it could reflect the marginal effect from both supplier and demanders. Therefore, these two advantages significantly help to manifest the statistical rationality, and each particular element in the model could be assigned a weight to show the relationship with the property value. The general form of the hedonic model is shown as following equation:

$$Price = \alpha + \beta_1 x_1 + \beta_2 x_2 + \dots \beta_n x_n + \varepsilon$$

In the equation, the attributes are represented as '*x*.' Structural attributes generally refer to the physical characteristics of the property, such as the number of bedrooms. Environmental attributes describe typically the characteristics of its surrounding built-environment, which has a broader range of components such as pollution and public services. Locational attributes

generally represent the accessibility to the working places and major public amenities, including the railway station.

In summary, though a lot of literature about job-housing separation, transit accessibility and determinant of the property value has covered a large number of cities and rapid transit modes, few studies are focusing on comparing the impacts of several railway stations accessibility on property value across a city. Therefore, I believe this research could fill the gap of exploring the difference between urban and suburban railway station accessibility.

CHAPTER 4 DATA DESCRIPTION

4.1. Data Sources

To better understand the property value distribution in the railway station area, this research uses property transaction data scraped from two China's professional housing information website: Lianjia Beijing (https://bj.lianjia.com/) and Anjuke Beijing (https://beijing.anjuke.com/). These two websites include massive interior information of the property and the neighborhood where the property is located. By collecting and organizing the transaction data, there are 76,917 transaction records and over 30 factors that may have impacts on the property value, prepared for the quantitative analysis.

4.2. Measuring Accessibility and Its Impacts

Based on the accessibility measurement in literature review, this research decides to use simple distance measure to present the accessibility. Simple distance indicates the straight-line distance between the property and the nearest railway station. Generally, an adult has an average walking

speed of 3.1 miles per hour. To better illustrate the radius of the railway station at a human scale, the latter analysis measures and represents the accessibility by walking time.

In this research, impacts from the railway station accessibility is defined by the change of the property value. Positive impact presents the accessibility is raising the property value and vice versa.

CHAPTER 5 METHODOLOGY: HEDONIC MODEL

For this research, locational characteristics of the property such as railway station accessibility and whether it is in the urban area are the focus. However, there are indeed more factors affecting the property value as well. The other factors include the interior characteristics of the property, external characteristics of the building and the neighborhood.

Therefore, in order to include all the related factors in the quantitative analysis, this research uses the hedonic model to answer the questions. As summarized in the literature review, the hedonic model is widely used for analyzing the factors affecting property value. By inputting different groups of factors, this model could calculate the specific correlation between property value and each factor.

From the previous chapter, this research has a raw dataset with 30 attributes describing the property. By sorting these attributes, these attributes were divided into four groups:

(1) The interior characteristics of the property (see statistical description in the Appendix, Table 1.): the area ***Area***, the interior design style ***Interior Design***, the bedroom number ***Bedroom Number***, the living room number ***Living Room Number***, the

kitchen number ***Kitchen Number***, the bathroom number ***Bathroom Number*** and the direction where the property is facing ***Facing***.

(2) The characteristics of the building (see statistical description in the Appendix, Table 2.): the level where the property is on ***Level***, the total floor number ***Floors***, whether or not the building is equipped with an elevator ***Elevator***, the ladder number ***Ladder Number***, the household number ***Household Number_1***, the ladder ratio ***Ladder Ratio***, the year when the building was built ***Built Year_1*** and the service fee for clean-up ***Service Fee***.

(3) The characteristics of the neighborhood (see statistical description in the Appendix, Table 2.): the household number ***Household Number_2***, the buildings number ***Building Number*** and the year when the neighborhood was built ***Built Year_2***.

(4) The characteristics of the location (see statistical description in the Appendix, Table 3.): the straight-line distance to the nearest railway station ***d***, and whether or not the property is located in the suburban area ***Built Environment***.

To identify the impacts of accessibility, this research used three forms of straight-line distance: ***d*** is d, ***d_1*** is 1/d and ***d_2*** is (1/d) *(1/d). Through the model, the impacts of railway station accessibility on property value are represented by different radius. Also, to explore the other locational characteristics, this analysis added an interaction between ***d*** and ***Built Environment***: ***d*Built Environment***.

5.1. Data Pre-processing

Data pre-processing could ensure the quantitative analysis more accurate and reasonable. Before inputting the transaction data into hedonic model, it is necessary to have a data cleaning progress. Here are the criteria used in this process:

(1) Since the sample size is big enough and the records with missing values are only a small proportion, therefore this research deleted all the transaction records with missing values. At the same time, although the raw transaction data has over 30 factors relevant, some variables have a high degree of multicollinearity, which is not satisfied the requirements of regression. Therefore, a group of attributes are deleted.

(2) This research selected the properties with a maximum distance of 8 km from the railway stations (Geng, Bao, & Liang, 2015). If the straight-line distance between the property and the nearest railway station is smaller than 8 km, the station accessibility might have impacts on the property value; if not, the accessibility's impacts might be too weak to affect the property. Therefore, the properties which didn't meet the conditions were removed.

5.2. The Specification of the Hedonic Model

After cleaning the raw data, a more organized dataset was created. This new dataset contains over 70,000 transaction records in the year of 2018. The hedonic model building process was conducted in R. The property value serves as the independent variable of the regression equation and have diverse relationships with the other input factors. These factors are dependent variables.

By inputting all dependent variables and independent variables into the model, the relationship between each factor and the property value is shown in Table 4:

Residuals:					
Min	1Q	Median	3Q	Max	
-819.96	-77.34	-10.35	56.29	504.80	
Coefficients:					
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.22E+03	3.40E+02	6.52	7.25E-11	***
Interior Characteristics of the Property:					
Area	3.71E+00	6.90E-02	53.711	< 2e-16	***
Bedroom Number	3.26E+01	2.11E+00	15.424	< 2e-16	***
Living Room Number	1.25E+01	2.45E+00	5.088	3.66E-07	***
Kitchen Number	-7.01E+00	1.28E+01	-0.55	0.582496	
Bathroom Number	9.90E+00	3.37E+00	2.942	0.003268	**
Interior Design_None	-1.99E+01	8.54E+00	-2.325	0.020086	*
Interior Design_Simple	-2.93E+01	1.94E+00	-15.109	< 2e-16	***
Interior Design_Others	-5.36E+00	2.90E+00	-1.848	0.064573	.
Facing_South	8.39E+00	2.28E+00	3.68	0.000234	***
Facing_Southeast	1.24E+01	3.67E+00	3.395	0.000689	***
Facing_Southwest	6.94E+00	3.72E+00	1.864	0.062356	.
Characterisctics of the Building:					
Level_Ground	1.50E+02	2.60E+01	5.765	8.30E-09	***
Level_Low	1.51E+02	2.58E+01	5.828	5.73E-09	***
Level_Middle	1.55E+02	2.58E+01	6	2.01E-09	***
Level_High	1.50E+02	2.58E+01	5.808	6.44E-09	***
Level_Top	1.29E+02	2.59E+01	4.99	6.11E-07	***
Floors	-3.16E-01	2.30E-01	-1.371	0.170314	
Elevator_Yes	5.45E+01	3.61E+00	15.081	< 2e-16	***
Ladder Number	-5.63E+00	1.14E+00	-4.922	8.66E-07	***
Household Number_1	-9.21E-01	2.33E-01	-3.962	7.46E-05	***
Ladder Ratio	2.87E+01	7.52E+00	3.813	0.000138	***
Built Year_1	1.17E+00	2.21E-01	5.295	1.20E-07	***
Service Fee	1.27E+00	1.77E-01	7.138	9.86E-13	***
Characterisctics of the Neighborhood:					
Household Number_2	-5.48E-03	7.94E-04	-6.903	5.29E-12	***
Building Number	-6.40E-01	1.09E-01	-5.896	3.80E-09	***
Built Year_2	-2.25E+00	1.40E-01	-16.126	< 2e-16	***
Locational Characteristics and Surrounding Built Environment:					
d	**-1.07E+01**	**7.64E-01**	**-13.952**	**< 2e-16**	*******
d_1	**5.04E+01**	**6.41E+00**	**7.864**	**3.95E-15**	*******
d_2	**-5.61E+00**	**1.21E+00**	**-4.64**	**3.52E-06**	*******
Built Environment	**-2.03E+02**	**6.40E+00**	**-31.661**	**< 2e-16**	*******
d*Built Environment	**5.97E+00**	**1.28E+00**	**4.683**	**2.85E-06**	*******

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 111.9 on 16231 degrees of freedom
Multiple R-squared: 0.616, Adjusted R-squared: 0.6152
F-statistic: 765.8 on 34 and 16231 DF, p-value: < 2.2e-16

Table 4. The Hedonic Model's Results

Throughout the model building and diagnosis process, the hedonic model is approved by significant testing. According to the results (Table 4), this model has significance in statistics and could be used for exploring the impacts of railway station accessibility and the built environment on property value.

5.3. Model Results

In order to answer the research questions, the results of the hedonic model are re-written into two equations:

(1) ***Affected Property Value*** = - 10.7****d*** + 50.4***(1/*d*)** -5.61***(1/*d*)^2**

(2) ***Affected Property Value*** = - 10.7****d*** – 203* ***Built Environment*** + 5.97 * (***d**Built Environment***)

In these two equations, the other independent variables keep constant and only locational characteristics are remained. Independent variable ***Affected Property Value*** indicates how much price is affected. In the first equation, property values are affected only by the distance to the railway station. While in the second equation, property values are affected by both the distance and the built environment. Typically, if the property is in the suburban area, ***Built Environment*** is 1 and if in the urban area, ***Built Environment*** is 0. Also, ***Affected Property Value*** is not necessarily a positive number because the overall impacts could be positive or negative.

From equation 1, the relationship between the accessibility and the property value could be plotted as a polynomial function (Fig.8.). Within a certain distance, the overall impacts of railway station accessibility are positive and raises the property value. However, beyond the scope, the overall impacts are zero or negative, which would make the property value unchanged or decreased. At the same time, the increased property value is not a constant number and it changes by radius. This research would focus more on the positive impacts.

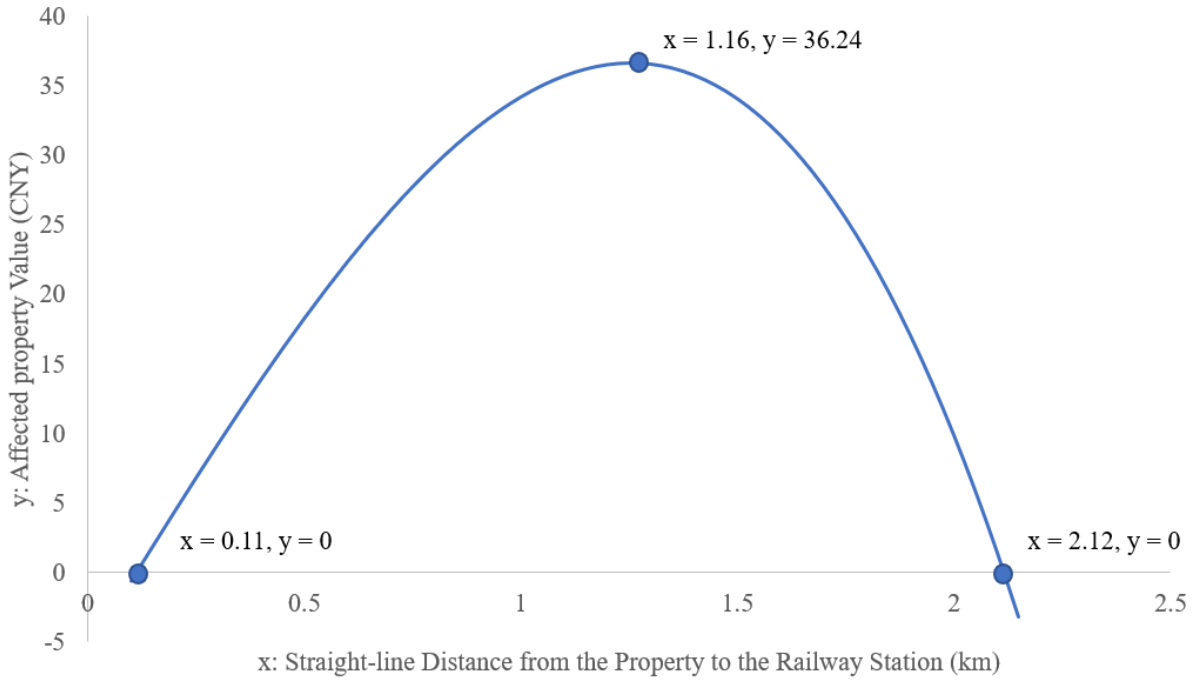


Fig.8. The Relationship between Railway Station Accessibility and Property Value

In Fig.8., there're several important points need to be highlighted:

(1) The first point has a distance of 0.11 km to the nearest railway station, and the affected property value is 0 CNY.

(2) The second point has a distance of 1.16 km to the nearest railway station, and the affected property value is 36.24 * 10,000 CNY.

(3) The third point has a distance of 2.12 km to the nearest railway station, and the affected property value is 0 CNY.

If taking built environment into consideration, the distance will have much different impacts on the property value. From equation 2, the interpretation of the interaction term could be plotted as Fig.9. Whether or not the built environment is suburban could play an essential role in determining property value. Typically, if a property is located in the urban area, the railway station accessibility could impact more on the property value; while the suburban railway station accessibility would have fewer impacts on the property value.

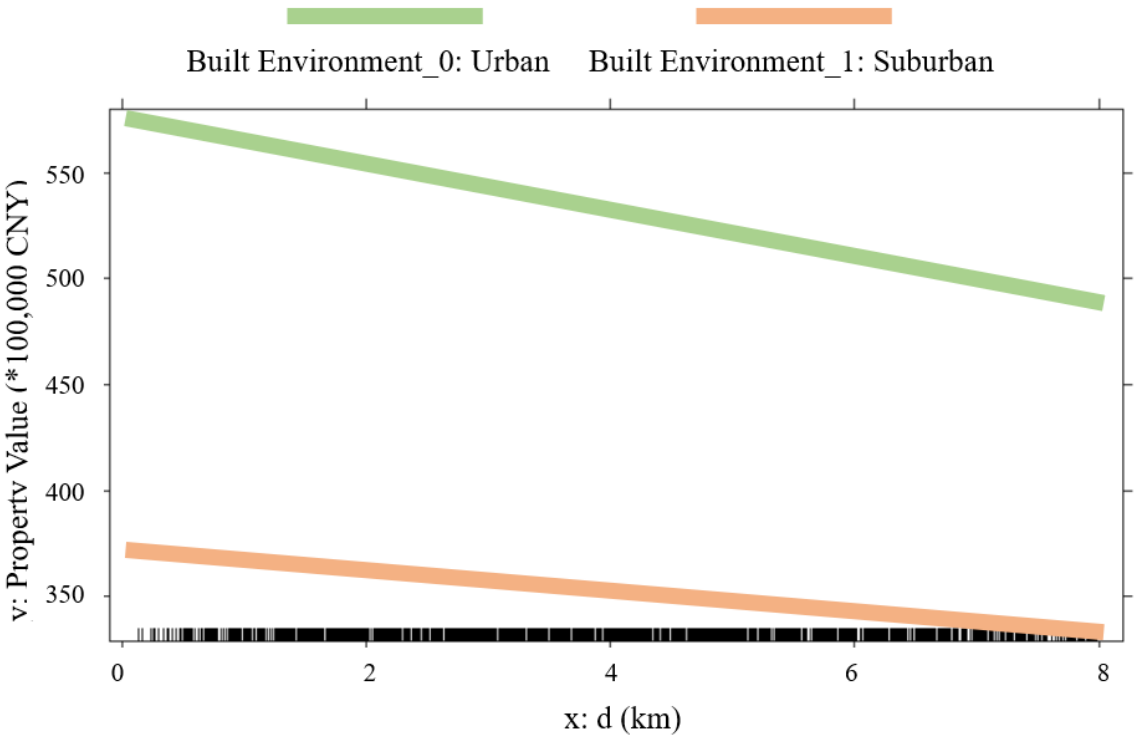


Fig.9. The Interaction's Effect: ***d*Built Environment***

CHAPTER 6 ANALYSIS: ACCESSIBILITY AND BUILT-ENVIRONMENT

This chapter examines the impacts of railway stations accessibility and the built environment on property value. In order to test the hypotheses behind the research questions, the following analysis pays more attention on the different radius and the type of the built environment.

6.1. Impacts of Railway Station Accessibility

In Beijing, all types of railway station accessibility show a general relationship with property value. In other word, property values near the railway station follow a similar distribution pattern. In order to better representation, the following analysis would be measured both by the unit of distance and walking time.

Within a radius from 0.11 km (2-min walk) to 2.12 km (30-min walk), the overall impact of the railway station accessibility is positive. Generally, the impacts on property value in different radius can be divided into two phases:

(1) Increasingly positive impacts on property value: When a property is in the radius within 1.16 km (16-min walk), railway station accessibility has an overall increasingly positive impact with increasing distance. Within this radius, the railway station not only provides better accessibility but significantly raises the property value. Usually, there are no properties within 2-min walk to the railway station, because of the high level of noise and pollution. Therefore, the nearest properties to the railway station will not be the most expensive. A peak value appears when the positive impacts subtract the negative impacts is maximum. Theoretically, if keeping the other factors constant, people could find the most expensive property after a 16-min walk from the railway station. Under this

scenario, railway station accessibility could raise the property value to the maximum: 36.24*10,000 CNY.

(2) Decreasingly positive impacts on property value: After reaching the peak value, the negative impacts increase, therefore the affected property value decreases. The negative impacts are from the decreased railway station accessibility and the other environmental factors. In this phase, accessibility plays an important role. Within a walk distance from 16-min to 30-min, the positive impacts decrease dramatically. When the property is 30-min walk away from the railway station, the positive impacts are equal to the negative impacts; therefore the affected property value is zero. If the property is beyond a 30-min walk, railway station's accessibility would not have an overall positive impact on the property, and the negative impacts finally exceed the positive impacts. Lacking accessibility to railway station devaluates the property.

6.2. Considering the Urban or Suburban Built Environment

From the previous model results, we could understand how much property value is different in the urban and suburban environment. According to Fig.9., keeping the distance from the property to the railway station unchanged, an urban environment would have much more impacts on the property value by distance. Given it is an urban environment, the railway station accessibility will decrease the property value with a rate of 10.7*10,000 CNY per km. However, if it is a suburban station, the accessibility will decrease the property value with a rate of 4.73*10,000 CNY per km.

On the other hand, if two properties have the same distance to the railway station, the one next to the urban railway station will have a higher property value. The average impacts from the urban

railway station could raise the property value by 197.03*10,000 CNY. Therefore, the built environment has many relationships with railway station accessibility, and this relationship affects the impacts of railway station accessibility on property value.

6.3. Impacts of Other Factors in Hedonic Model

Besides the locational characteristics of railway station accessibility and the classification of the built environment, this section summarizes the relationship between property value and the other factor. According to the hedonic model results, independent variables have different relationship with property value. Therefore, the following analysis looks at three dimensions: (1) the interior characteristics of the property; (2) the characteristics of the building; (3) the characteristics of the neighborhood.

6.3.1. The Interior Characteristics of the Property

The interior characteristics of the property includes either positive or negative impacts on the property value (see details in Table 4). Consistent with common sense, the factors including ***Bedroom Number***, ***Living Room Number*** and ***Facing*** are playing an essential role in determining property value. They have positive relationships with property value. For the factors of ***Area*** and ***Bathroom Number***, they also have positive impacts, but fewer than the previous factors. As for ***Interior Design***, a property with a good design will not make a difference in property value; while a property with a bad design will devaluate the property significantly.

Surprisingly, if the property is facing southwest, it could be more expensive than the other directions. Even though facing the other directions will not greatly impact property value, but if

the property is facing south, southeast or southwest, this property is with higher value. Among the impacts from a different room type, ***kitchen number*** might decrease property value.

6.3.2. The Characteristics of the Building

The characteristics of the buildings also have either positive or negative impacts on property value (see details in Table 4). Typically, ***Elevator*** impacts the property value most. If the apartment building has an elevator, then the property value is higher. However, if there is no elevator in the building, this condition will not devaluate the property.

As for the other factors, also constant with our common sense, higher service fee (***Service Fee***) in the building always means a better environment; therefore, the property value increases with a higher fee. Higher ladder ratio (***Ladder Ratio***) could provide more accessibility to the neighborhood and therefore increase property value. At the same time, a newly-built apartment building (***Built Year_1***) is always with better amenities. Therefore, the newer the building is, the higher the property value could be.

More floors (***Floors***) and households (***Household Number_1***) in the building always a sign of high density. These two characteristics decrease property value.

The characteristic of the level where the property is on (***Level***) show different among different values. The properties on the top level is cheapest, keeping the other factor constant. Living in the middle level costs most. The properties on the ground level and high level always share the similar prices. And for the properties on the low level, the prices are slightly lower than the ones on the middle level.

6.3.3. The Characteristics of the Neighborhood

Form the aspect of the characteristics of the neighborhood, property value changes in another way. From the results, it is evident that if the property is in an old neighborhood (***Built Year_2***), it will have a higher price. This correlation seems contradictory with the characteristics of the building. However, it indicates that the older neighborhood always next to the urban core; therefore this locational advantages could raise property value. At the same time, it is permitted to build new buildings in some old neighborhood, which is consistent with the previous conclusion. Old neighborhood is always surrounded with good schools and has better access to the other part of the city, which makes the property attractive.

For the building numbers (***Building Number***) and household size (***Household Number_2***) in the neighborhood, they are similar with the results of building's characteristics. More buildings and families in the neighborhood indicate a higher density and a high probability of bad environment. In this scenario, more people contribute to a cheaper property.

6.4. Amenities Density Analysis

As shown in the hedonic results, there is a peak value of property value by distance. Therefore, this section explores the reasons behind the peak value. By considering diverse amenities, the following analysis figures out the urban and suburban built environment interacts with the impacts the railway station accessibility on property value. The statistical analysis used the density of each amenity in two areas: (1) Area One. In this area, the properties have the distance from 0.11 km to 1.16 km away from the railway station; (2) Area Two. In this area, the properties have the distance from 1.16 km to 2.12 km away from the railway station. This section selected four amenities, which are educational facilities, green spaces, commercial places and working places.

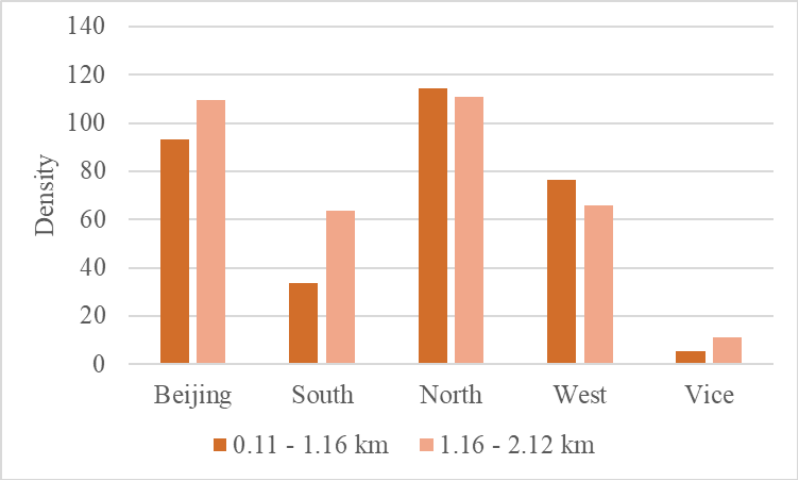


Fig.10. The Density of Educational Facilities in the Different Station Area

First of all, as for the density of educational facilities. Urban railway stations have more this type of land use in its proximity than the suburban railway station. According to Fig.10, the difference of the density between Area One and Area Two is not evident. Therefore, we could say, the educational accessibility could not have positive impacts on property value.

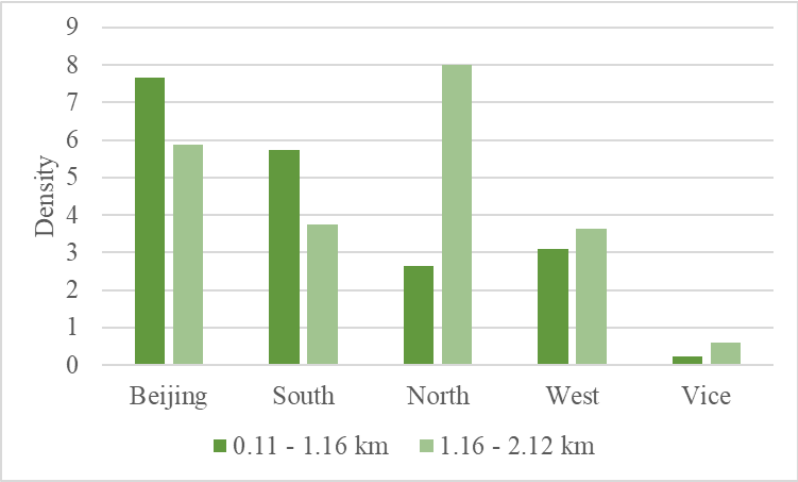


Fig.11. The Density of Green Spaces in the Different Station Area

Then, the density of the green spaces among the railway stations are also showing the similar pattern. Even though there are more green spaces near the urban railway stations, the change of value between Area One and Area Two could not interpret the peak value.

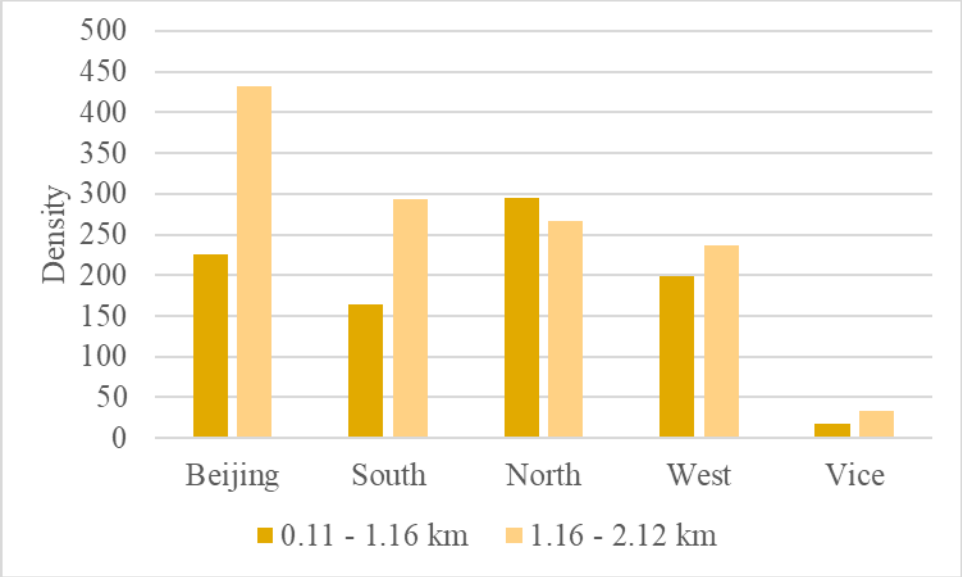


Fig.12. The Density of Shopping Places in the Different Station Area

Next, as for the density of shopping places in the different station area, the conclusion is this density could be the factor impacting property values. The impact is positive. From Fig.12., there is a higher density of shopping places in Area Two, which indicates the concentration of the shopping places helps to compensate for the decreasing railway station accessibility in that segment. More shopping places could raise property value.

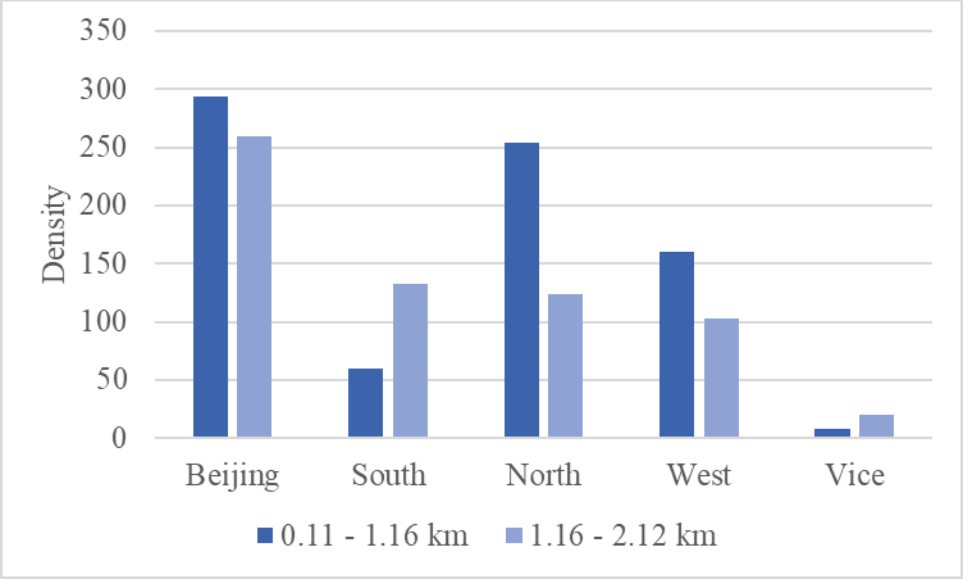


Fig.13. The Density of Working Places in the Different Station Area

Finally, the density of working places plays an essential role in impacting property values. Since Beijing Station, North Station and West Stations are closer to the urban core, and the South Station is on the edge of the urban area, therefore classifying South Station and Vice Center Station as a group. As shown in Fig.13., the railway stations near the urban core always concentrate more job opportunities; while the stations away from the urban area have fewer working places. This spatial distribution pattern contributes to reaching the peak value in Area One. The lower density in Area Two doesn't help to compensate for the decreasing accessibility. Therefore, we could conclude that working places have negative impacts on property value. "Job-housing balance" is actually happened near the urban railway stations.

CHAPTER 7 CONCLUSIONS AND LIMITATIONS

7.1. Conclusions

Even Beijing has "big city diseases" of lacking affordable housing and long commuting times, its public transit network releases the pressures significantly. To better solve the urban issues,

Beijing has built lots of transit hubs across the city. Since public transit could bring more accessibility, especially to the people doesn't have automobiles, living next to the transit hubs is always expensive. Typically, because the railway station is the only transit hub that could provide both inner- and inter-city transit; therefore it is crucial to explore the impacts of railway station accessibility on property value. Moreover, given the built environment always has a relationship with railway station accessibility, this research brings forward an innovative empirical study: considering the built environment when analyzing the impacts of railways station accessibility. By understanding the relationship, diverse groups of stakeholders could take advantages of it. The stakeholders include urban planners, residents who want to buy a property, and the developers.

In order to explore the relationship, this research applies the hedonic model in quantitative analysis to get the numeric results. The results well answered the research questions and tested the research hypotheses. The main conclusions from the analysis results are as follows:

(1) Without considering the built environment, the overall impacts of Beijing's railway stations on the property value is positive within a certain radius. Setting one of the urban railway stations as the circle center and keeping the other variances constant, the property value would increase first then decrease. This radius is generally from 0.11 km (2-min walk) to 2.12km (30-min walk) in Beijing, and property value would theoretically reach the peak when the radius is 1.16 km (16-min walk). Beyond this scope, the railway station would have negative impacts on property value, which is decreasing the prices. In the first phase of increasing property value, railway station benefits the property by providing better access to the other part of the city. In the second phase of increasing

property value, although the railway station accessibility is still high, there are more environmental factors such as the land use type have negative impacts.

(2) The railway station accessibility has significantly relationship with the built environment. Therefore, if taking the built environment into consideration, whether or not the station is located in the urban area is essential. this research found that the suburban railway station has much more impacts changing property value. The average impacts from the urban railway station could raise the property value by 197.03*10,000 CNY. At the same time, the urban railway station could change the property value with a higher rate. In an urban environment, the railway station accessibility will decrease the property value with a rate of 10.7 *110,000 CNY per km. However, if it is a suburban station, the accessibility will decrease the property value with a rate of 4.73*10,000 CNY per km.

(3) By analyzing the density of four types of land use near the railway stations, this research finds that the educational facilities accessibility and green spaces accessibility do not necessarily impact property value. On the other hand, the shopping places accessibility and working places accessibility have many impacts on property value. This finding could be interpreted that commercial and office land use have many interactions with railway station accessibility.

7.2. Limitations

This research has achieved the initial goals and successfully tested the hypotheses, and owns several merits compared to the previous literature such as exploring a property value distribution pattern across a city and providing a feasible methodology to study the impacts of railway station

accessibility. However, because of the time and technique limitation, several aspects could be improved in future work.

(1) From the aspect of the case study, although it has already considered five main railway stations, it failed to include all types of railway stations in Beijing. As shown in the distribution map of the public transit nodes, there are actually more stations playing an important role in the public transit system. They are freight-only railway stations, smaller railway station with both passenger and freight transit, and the other subway stations. If this research could take all types of the transit hubs into considerations, there would be a more precise results by the hedonic model. These stations are distributed across Beijing with different built environment. In this way, the difference would be much bigger for the urban and suburban stations.

(2) Limited to the data acquisition capacity, the research cannot make a time-series comparison of property value. From the previous literature, it is evident that the hedonic model could identify more relationship between the transit hub and property value if there are historical transaction records. Moreover, if the research could get more than one year's transaction records, the model results and the estimated property value will be more precise.

(3) Because of the insufficient data acquisition, there is few amenities accessibility inputting to build the hedonic model. Although in the later analysis, this research tried to use the density of each amenities to explain the hedonic model results, it could only get a general relationship between the property value and the amenity accessibility rather than an exact numeric coefficient. More broadly, if there are some amenity accessibility in the model as

the part of locational characteristics, the interaction between the built environment and land use pattern in the station area would be more specific for future development.

(4) During the analysis process, the research should include more qualitative analysis instead of merely using the data to tell a story. So far, the research has proved the railway station has different impacts on the property within different radius and under different built environment. However, in this residents-related research, residents' demographics and the willingness to choose rapid transit as a commuting tool should also be integrated into the analysis in the future work.

CHAPTER 8 RECOMMENDATIONS FOR PLANNING

8.1. Regional Planning for Job-housing Balance

From the aspect of planning in the railway station area in Beijing, several thoughtful planning strategies could be derived from the results and the findings of this research:

(1) Future planning needs to be more "job-housing" oriented. The new sub-center in the suburbs is continuously developing to release the "job-housing" pressure in Beijing, and the central government indeed implement the policy to move some important working places there. However, the proposed re-located working places are limited to city government and some state-owned enterprise, some more attractive jobs including high-tech and financial-related companies are still concentrated in the urban area. Apparently, although people who are working with technology and business are willing to pay less to live in the sub-center, the station is only serving for decreasing the commuting time rather than solving "job-housing separation." Therefore, the intervention between the demographics and jobs should be taken into consideration. I recommend a combination

of a “top-down” and “bottom-up” planning strategy. On the one hand, the central government and the local municipalities are responsible for allocating urban resources and provides support for moving the working places into the subcenter; on the other hand, the people who have more needs for lower property values could play an essential role of deciding which working place should be allocated.

(2) Based on the transaction records in recent one year, the purchase requirement is obvious. The apartment buildings are generally new-built, which indicates the station area always has high residential development potential. In summary, for residential planning, the station area needs more high-rise apartment buildings with an elevator. At the same time, two-bedroom property with a mid-size and fine decoration is much-needed. Therefore, the future residential development should focus on high-density and better interior design, which benefits both to the developers who attempt to earn profits and to the buyers who have a preference in the property. Also, since the housing market is changing all the time along the policy and the other factors, a unified property management platform is recommended to better adjusting the property value and recording the historical transactions for future analysis.

(3) In order to make full use of each piece of land in the railway station area, mixed-use planning and transit-oriented development are highly recommended. Especially for the suburban railway station, there are massive lands in the station area is under-developed. In the future, the goal of the railway station project could be transit-oriented and providing more affordable housing. Under this planning framework, planners could scientifically integrate land use planning, economic planning, and transportation planning into one planning process. Also, by analyzing the amenities density, one current problem

in the suburban railway station area is that there are fewer educational facilities, green spaces, shopping places and working places there. All these environmental elements decrease property values. Notably, promoting mixed-use is not merely a mixture of different land use. Therefore, future planning in the suburban railway station should pay more attention to improving connecting the urban area, and increase social equality by providing more amenities for the local people.

8.2. Residential Planning in Railway Station's Area

Different distance to the railway station demonstrates different accessibility to public transit. As mentioned before, people always concern about commuting cost and actual property value when choosing a living place. The research has plotted a theoretical property value distribution by distance in the station area, and here are some recommendations for buying a more cost-effective property in the context of "job-housing separation."

From the results of amenities density analysis in railway stations, the suburban railway station shows more planning potential in the future. Developers should focus on investing residential projects within the scope from 0.11 km (2-min walk) to 2.12 km (30-min walk) near the station area, especially for the area which has the straight-line distance of 1.16 km (16-min walk) away from the railway station. Developing a residential project in this distance could bring the developers the most profits. Moreover, since the radius with the positive impacts are within walk distance, therefore it is reasonable to promote transit-oriented development in the railway station area. In this scenario, more mixed lands will be created and significantly raising the land values. Also, this development strategy could benefit the local people with a more sustainable lifestyle.

For the buyers, they should notice that property values are much higher in urban station area than suburban station area. Therefore, if they could not afford a property near an urban station, choosing a property near the suburban station is optimal. Meanwhile, by weighing property values and the railway station accessibility, buyers might put more attention on the property in the scope from 1.16 km (16-min walk) to 2.12 km (30-min walk). Since within this scope, they could not only enjoy better access to the railway station but also have more high-quality amenities. Moreover, the property values would not that high because of the weaker locational superiority. Therefore, most people could find their idea houses in this area.

APPENDIX

Variables	Symbol	Definition	Measurement
Interior Characteristics of the Property			
Area	Area	The total area of the property including inner area and sharing area	(Square Meters) Min. = 15.79 Mean = 77.08 Max = 387.83
Interior Design	None, Simple, Fine, Others	The property doesn't have any decorations The property has simple decorations The property has fine decorations The property has the other types of decorations	(Samples) None = 177 Simple = 5,948 Fine = 8,265 Others = 1,876
Facing	South, Southeast, Southwest, Others	The property is facing south The property is facing southeast The property is facing southwest The property is facing the other direction	(Samples) South = 8,567 Southeast = 1,233 Southwest = 1,189 Others = 5,277
Level	Basement Ground, Low, Mid High, Top	The property is on the basement The property is on the ground level The property is on the low level The property is on the middle level The property is on the high level The property is on the top level	(Samples) Basement = 19 Ground = 900 Low = 3,664 Mid = 6,438 High = 3,816 Top = 1,429
Built Year_1	Built Year_1	The year when the building is built	Min. = 1950 Mean = 2001 Max = 2015
Bedroom Number	Bedroom Number	The number of bedrooms inside the property	Min. = 1 Mean = 1.829 Max = 6
Living Room Number	Living Room Number	The number of living rooms inside the property	Min. = 0 Mean = 1.042 Max = 3
Kitchen Number	Kitchen Number	The number of kitchens inside the property	Min. = 0 Mean = 0.9977 Max = 2
Bathroom Number	Bathroom Number	The number of bathrooms inside the property	Min. = 0 Mean = 1.121 Max = 5

Table 1. The Summary of Interior Characteristics of the Property

Variables	Abbreviation	Definition	Measurement
Characteristics of the Building and Neighborhood			
Elevator	Yes, No	The building is equipped with elevator(s) The building isn't equipped with any elevator	(Samples) Yes = 11,812 No = 4,454
Ladder Number	Ladder Number	The number of ladders inside the building	Min. = 1 Mean = 1.743 Max = 30
Household Number	Household Number	The number of the household per floor	Min. = 1 Mean = 7.136 Max = 98
Ladder Ratio	Ladder Ratio	The ratio of ladder to household per floor	Min. = 0.02041 Mean = 0.34801 Max = 4
Service Fee	Service Fee	The service fee per square meters	(RMB/ Square Meters) Min. = 0.5 Mean = 1.692 Max = 615
Floors	Floors	The floor numbers inside the building	(Floors) Min. = 2 Mean = 15.56 Max = 42
Building Number	Building Number	The number of the building inside the residential district	Min. = 1 Mean = 15.68 Max = 128
Built Year_2	Built Year_2	The year when the residential district is built	Min. = 1905 Mean = 1997 Max = 2015

Table 2. The Summary of Characteristics of the Building and Neighborhood

Variables	Abbreviation	Definition	Measurement
Locational Characteristics			
Distance to the Nearest Station	Distance_to_Station *(d)*, Distance_to_Station_1 *(1/d)*, Distance_to_Station_2 $(1/d)^2$	The direct distance (km) to the nearest railway station The reciprocal of 'd' The square of '1/d'	d (Kilometers) Min = 0.1346 Mean = 4.3479 Max = 7.9808
Built Environment	Urban, Suburban	It is the urban built environment It is the suburban built environment	(Samples) Urban = 9,315 Suburban = 6,951

Table 3. The Summary of Characteristics of the Locational Characteristics

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