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How will proximity to higher education affect the rental housing market? A case in Beijing.

A regression analysis of rent level in Beijing.

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Master of Science thesis

Title	How will proximity to higher education affect the rental housing market? A case in Beijing.
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Abstract

Education would always be an important issue in China. Capitalization of education would have impact on housing price and rent price and affect the housing market, this can be reflected from the phenomenon of 'over-priced school district house'. While the capitalization of higher education on rent price is always be neglected.

In that case, the propose of this study is to estimate the relationship between higher education and rental market price level in China based on the rental market in Beijing. And the study would focus four zone in Beijing, each of them contains one to two university district and surrounding non-university district.

Hedonic pricing model would be used in this study to determine the impact of independent variables on the rent price development.

The result of this study indicates a complex relationship, it finds that the relationship between higher education and rent price in different zones while most zones shows a positive relationship, and the overall result is insignificant. And according to our research, some target suggestions were pointed out.

Examensarbete

Titel	Hur påverkar närheten till akademisk utbildning hyresmarknaden? Ett fall i Peking.
Författare	Minggang Feng
Institution	Institutionen för Fastigheter och Byggande
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Abstract

Utbildning är alltid en viktig fråga i Kina. Kapitalisering av utbildningen skulle få inverkan på bostadspris och hyrespris och påverka bostadsmarknaden, vilket kan återspeglas från fenomenet "dyrt skolhus". Medan kapitalisering av akademisk utbildning på hyreskostnaden alltid försummas.

I det fallet är förslaget till denna undersökning att uppskatta förhållandet mellan akademisk utbildning och hyresmarknadsprisnivå i Kina baserat på hyresmarknaden i Peking. Och studien skulle fokusera på fyra zoner i Peking, var och en av dem innehåller ett till två universitetsdistrikt och omgivande icke-universitetsdistrikt.

Hedoniska prissättningsmodell skulle användas i denna studie för att bestämma effekterna av oberoende variabler på hyresprisutvecklingen.

Resultatet av denna studie indikerar ett komplicerat förhållande, det konstaterar att förhållandet mellan akademisk utbildning och hyrespris i olika zoner medan de flesta zoner visar ett positivt förhållande och det övergripande resultatet är obetydligt. Enligt vår forskning pekades några målförslag ut.

Preface

Education is the foundation of everything, it is the driving force behind social progress and development. The idea of this thesis firstly appeared when I focus on the main social problems in China, housing problems and education problem. The capitalization of education would have impact on housing price and affect the housing market. When measuring the effect, it is mostly omitted the higher education.

And I would like to thank everyone who have helped me. Firstly, I would like to thank Mats Wilhelmsson, my supervisor who has given me the opportunity to research on the rental market in Beijing and supported the thesis with his knowledge and patience. Secondly, I would also like to thank the real estate company, Mats and Zisheng Song that enabled me to use the database and do the analysis. Then, I would like to thank my families who always support me and love me even if they are thousands of miles away. At last, I would like to thank my friends who have accompanied with me during the master programme, especially Mr. Xinchen Lu, Miss. Zifan Li, Mr. Yifan Zhang, Miss Yujue Wang and Mr. Zheng Huan who have helped me when I was in trouble, who have encouraged me when I felt depressed and who have cheered for me when I made progress. You are the rainbow in my sky and the stars in my night. Cannot imagine life without you, at least the rainbow colored my sky and the stars illuminated my night.

I always remember the first day I came to Sweden, came to KTH. Carried my luggage and bathed in the sun, I said, life here would be fantastic. Yes, this is indeed a fantastic experience. I will never forget.

Stockholm, May 2019

Minggang Feng

Contents

1. Introduction

1.1. Background

Education and housing are two fundamental rights for human beings, while they interact and intertwine.

In China, most of the children would experience five stages of education including kindergarten, primary school, junior high, senior high and higher education. The enrollment of kindergarten, primary school and junior high is determined by the school district (Zheng et al., 2016) and the enrollment of senior high would also be restricted in a specific district. While for higher education, students will never be restricted by the geographical factor which means they will have opportunities to be admitted by each university all over the country if they are qualified through the college entrance examination.

With the development of economy and society, higher education flourishes these years. Especially in some developing countries, like China, plenty of universities held in these years and the number of university students also booming these years (National Bureau of Statistics of China, 2019), which makes the government offer policies, lands and funds to support the development of higher education.

The exist of 'school district' affect the housing market and it has been demonstrated by many articles. While for higher education, there is no specific 'school district'.

1.2. Problem statement

The impact of primary and secondary schools on the housing market has been discussed by many scholars. Due to the difference in enrollment of different education stages, the impact of higher education may not have such strong impact on the housing market. And the related thesis about higher education and housing market is also scarce.

In China, due to the educational resource concentration, giant cities own the vast majority of top universities which lead to the fact that most university students have to leave their home and move to another city for further study. Universities need to provide their students dormitory with a fixed fee, while there is a trend that some students still choose to live off campus because unlike other countries, students dormitories in China generally have four to six students, the limited facilities of dormitory, complex relationship between roommates and the requirement of privacy could be a huge problem for students. For living off campus, most of student would rent an apartment or a room near their university

because they cannot afford a property. Nowadays, traditional student dormitory cannot satisfy students and the trend become more popular.

Not only for students at school, other renters would also be attracted by the facilities of university such as stadium, library, study room and canteen which would provide renters a convenient life.

1.3. Purpose

This thesis would try to investigate the relationship between higher education and rental housing market in China, Beijing. The rental housing market in China is rising these years, while it is still not a mature market (JLL, 2018). When implementing public rental policies this thesis could offer a direction for the policy maker, and it could help the government make more accurate and suitable decisions on the location of higher education and urban development. For renters and investors, these would benefit them.

Furthermore, this could also help decision makers better understand the market and promote the further development of the rental housing market in China.

1.4. Research question

How has the higher education affected the rent price development in the China, Beijing as well as the specific research areas?

1.5. Outliner

This thesis contains seven sections. In the second section, the literature review introduces the relationship between property and public goods especially educational facilities. In the third section, hedonic pricing model and relative statistic theory would be presented as well as the regression model. Section four shows the database from rental housing market in Beijing and focus on how to gain new variables, process the data and select appropriate variables. The fifth section describe the empirical results from the regression model and the analysis would be presented in section six. In the sixth section, the limitation and the problems during this study would be discussed. Finally, in the last section is the conclusion of this study and also provide the direction for further study.

2. Literature review

2.1. Public goods and property market

The relationship between public goods and housing prices is always a popular topic in real estate economics. Tiebout (1956) firstly proposed that fully mobile consumers could choose a region where has public goods that they are willing to pay for, meanwhile due to the competition, these public goods would be offered more reasonable and economic. Based on the study of Tiebout, Yinger (1982) added tax into assumption and proposed that the public goods would distort the property market and alter the price of housing, thus changing the household consumption of housing.

Researchers had proposed different kinds of public goods like sport, transport facilities and green area would affect the property market.

Several studies show that the sport facilities would have a significant and positive effect on surrounding property (Tu, 2005; Ahlfeldt and Maennig, 2010; Feng and Humphreys, 2018). Especially, Tu (2005) found that the housing price improvement would increase if the property is closer to the new sport center. However, Dehring et al. (2007) got an opposite conclusion after evaluating the case in Dallas.

Transport facilities would also affect the property market, Damm et al. (1980) and Grass (1992) Debrezion et al. (2010) proved the capitalization of highway, railway and metro station in real estate market, the property value would have relationship with the distance to the metro station in America and Netherland, as well as in some developing countries (Murat and Yankaya, 2006).

Green area facilities would also affect the property market (Troy and Grove, 2008; Jung et al., 2016; Wu et al., 2017), their studies conducted that large park would attract and gather more residents and the property value would increase in USA, China and Korea.

In China, researchers demonstrated that public goods would affect the property market. Feng et al. (2011) studies Beijing Metro Line Five and found that the metro line would have the most significant effect on the property value while the number of parks, high-quality schools and normal-quality schools have insignificant effect. After analyzing 1840 samples in Xiamen Island, Yang et al. (2016) concurred that the walkable educational and commercial service would benefit the property value while the medical facility has the negative effect. However, by selecting five types of public service facilities in Beijing (e.g., hospitals, parks, shopping malls, cinemas and museums), Lu et al. (2017) analyzed

that cinemas and museums have a positive impact on property value, while large hospital have a negative impact on housing market. The results are different because of the difference in location and time.

2.2. Education and property market

Education is one of the most significant factors in public facilities affecting the property market and the capitalization of education in property value has been estimated by researchers. Oates (1969) firstly indicated that educational factors will be capitalized in

housing prices. After that, Rosen and Fullerton (1977) confirmed that there is a positive relationship between education and property value by using hedonic price model.

Researches explored different analysis strategies. By employing the Boundary Fixed Effect (BFE) Method, Black (1999) proved the positive relation between school quality and housing market while Gibbons et al. (2013) added matching regression in BFE method. A variety of variables were added in the model, such as demographic variables (Bayer et al., 2007), district or area fixed effect variables (Clapp et al., 2008), the exam grades (Dhar and Ross, 2014) and the average educational expanse (Guo and Lu, 2009).

In China, educational facility becomes one of the most important factors in property market. Wen et al. (2014) developed a hedonic model to quantify the impact of different stages of education on property market in Hangzhou, the result showed that from kindergarten to collage, all stages of educational facilities have positive relation with property market.

Researchers measured the how much will different stages of education and school quality capitalized in property market. Feng & Lu (2013) employed a natural experiment to measure the relationship between high school quality and housing price and proved the school quality have positive effect on housing market based on data from 52 residential area in Shanghai. Zheng et al. (2016) provided the evidence on the capitalization of school quality in home values in Beijing by testing 40 key primary schools as well as resale and rental transaction records in Beijing.

However, most of researches of the capitalization of education in property market in China selected the stage of primary school and high school as the main variables, few studies concentrate on higher education. Only rare studies (Zheng and Kahn, 2008; Wen et al., 2015) treated higher education as a control variable.

2.3. Higher education

Compare to primary school and high school, higher education would have diverse effects on property market. From the direct aspect, higher education could attract investment for itself and even for the neighbor, and from the indirect aspect, higher education would affect the life quality in surrounding areas (Zhong et al., 2018).

Everything has its two sides as well as higher education. The higher education campus would bring positive effect to the property market. Firstly, the higher education would create demand of housing market directly. Higher education campus always has a large population of students and faculties and the number increase these years which would increase the demand around the campus. Then, the amenities in the campus would also benefit the local residents. They could study in the library, visit the exhibition in the museum, enjoy free time in the stadium and so on. Finally, the surrounding environment of the campus would change and affect property market positively. For example, commercial area would be located close to the campus to convenient students' life and with the development of technology innovation activities always happen near campus area. These environment changes would also benefit the property market.

The higher education would cause not only positive effect but also negative impact on the market. Students and recent graduates would prefer to choose campus area when settle down, and it would create low-cost rental housing demand, Shilling et al. (1991) proved that investment to the property would decrease due to the increase in rental occupancy. And the booming of rental property would also shock the local residents and market balance (Cortes, 2004).

Based on data from five cities in the United States, Cortes (2004) found that the private university would have a positive impact on housing price while the public university would have both positive and negative impact. Zhong et al. (2017) conducted research in Nanjing, the result showed that the first-tier university would have positive impact on housing market.

2.4. Rental housing market in China

Compared to house transaction prices, the rental prices have more flexibility to reflect the facilities that surround the residential area and is an indirect indicator reflecting the allocation and distribution of public service facilities all over the area.

Rent is the core of the rental housing market. Understanding the rent space structure will help strengthen the management of the rental housing market, realize management differentiation and improve management efficiency (Su et al. 2014). The researches on the factors which affect residential rent includes both micro and macro aspects. The researches on micro level are based on the individual lease transaction in the residential leasing market while for macro level researches, they are always empirical studies of the effect brought by different social attributes such as urban population, family structure, land use, and fiscal revenue on rents from the urban level (Lu et al. 2017). While in China, researches on the micro level is relatively scarce. This situation happens because the domestic residential leasing market is not as mature as foreign residential leasing market, and the current focus is still on house prices and land prices (Su et al. 2014).

In addition to location differences, housing differences, and payment capabilities difference, the distribution of public service facilities and spatial characteristics has gradually become significant factors affecting rent. (Lu et al. 2017).

2.5. Hypothesis

To accurately measure the relationship between higher education and rental housing market, based on my literature review, the following hypothesis will be proposed:

- Keep other variables equal, the higher education would have a positive effect on the rental housing market.
- With the increase of the number of students and faculties, the rental market would have a positive trend.

3. Methodology

Housing sector is one of the most important part of economy and the development of housing market is closely related to the economy. So, the analysis of influencing factors in housing market become important and essential.

Two methods have been widely used in an effort to simulate housing prices. The first is the monocentric model which assume that the housing price is a function of proximity to a single workplace. Meanwhile, the price reflects the cost saving in commuting (Chaw and Chin, 2003). Alonso (1964) used the monocentric model and indicated that with the increasing in the distance to the urban area, the rent level would decrease relatively.

Nevertheless, the housing has its unique characters including durability, heterogeneity and spatial fixity, the first method cannot satisfy the analysis, the second method would be employed, and the method is called hedonic price model.

3.1. Hedonic price model

The hedonic price model is one of the most commonly used models in property market research. In 1939, Court firstly introduced the conception of 'hedonic' and researchers like Griliches (1961) developed this theory. Afterwards, Lancaster (1966) introduced a new approach to consumer theory that he believed the utility of commodity should on the basis of its several individual composite characters instead of commodity itself. Rosen (1974) proposed a hedonic hypothesis that for each good, its value is based on their utility and this hypothesis is the fundamental of hedonic model. The hedonic price is the total amount of its implicit prices. And he firstly introduced the hedonic model. Compare to Lancastrian model, Rosen's model is more suitable for durable goods including the property (Chaw and Chin, 2003).

In property market, a property can be explained as a bundle of characters including locational attributes, structural attributes including the quality of the property, environmental attributes and so on. Therefore, each property is unique and compare to another property, the difference in housing prices is reflected in their different additional attributes. The equation of this hedonic model would be

$$P = f(S,E,L)$$

where P is the price of the property, S is the variable of structural attributes, E is the variable of environmental attributes, L is the variable of locational attributes.

3.2. Model selection

In the hedonic pricing model, the functional form would be diverse including linear form, semi-log form, log-log form and so on. The different choice of the functional form may lead to inconsistent results (Goodman, 1978; Bloomquist and Worley, 1981).

The market segmentation is also controversial in hedonic pricing model. There is no requirement of market segmentation in hedonic pricing model (Feitelson et al., 1996). While the property market is not uniform (Adair et al., 1996), there still have market segmentation in the property market now. Even most of the researches had used location, political boundaries, demographic data or social data to segment the market (Michaels and Smith, 1990), the best segmentation method and differences measurement is still not conclusive. A broad market segmentation may lead to a biased estimation while a narrow market segmentation may result in an inaccurate rating (Linneman, 1980).

Variables specification is another common issue related to hedonic price model. Misspecification happens when containing irrelevant independent variables or omitting a relevant independent variable (Chaw and Chin, 2003). Butler (1982) believed that, generally, it would be sufficient if using few key variables which have higher utility and production cost in the model due to a certain degree of misspecification. Mok, et al. (1995) proved that even the missing variables would result in bias, the bias would be small and will not affect the persuasive of the estimation and result.

For the property market, the hedonic pricing model have been widely used in estimating marginal price of property market factors. While there is no specific market to measure the value of different characters of the property, so the value of each characters of the property should be observed by using multiple regression. Based on several researchers (Witte et al., 1979; Tu, 2005; Zheng et al., 2016), in this case, the equation of the model would be

$$P = \alpha_0 + \alpha_1 X_L + \alpha_2 X_Q + \alpha_3 X_S + \varepsilon + \eta$$

where P is the price of property, α and β are the coefficients, X are variables, ε is omitted variable and η is an error term.

Hedonic pricing model is also widely used in property market in China. Sun et al. (2015), Zheng et al. (2016) and Xiang (2018) used hedonic price model to process the data to measure the effect of metro stations and primary schools.

4. Data

4.1. Study area

Beijing, the capital city of People's Republic of China and also the political center, cultural center and education center of the county. At the end of 2017, Beijing owns 175 higher education universities with more than 145,000 faculties and 2,000,000 higher education students (Beijing Municipal Bureau of Statistics, 2018). While the distribution of universities in Beijing is imbalanced, especially for first-tier university. Most of them located in Haidian District and consist a big higher education area while the area is too big to analyze.

In the database of this study, the city is divided into more than 70 business districts according to the business area and administrative districts. I use the business district as the specific area to implement the analysis. I select four small university zones in Beijing and far away from the big higher education area, each of the zones contains only one or two business districts with universities and surrounding business districts without university would be the control group

	Zone Ⅰ	*Zone Ⅱ*	*Zone Ⅲ*	*Zone Ⅳ*
Zone name	Dongguan	Hepingli	Dingfuzhuang	BUT
Number of business zone	4	8	5	5
Number of universities	2	4	2	1
Number of students and faculties	31500	45600	28000	22000

Table 1. General introduction of study area

These fours zones contain 22 business zones and nine universities with almost 127,100 students and faculties, the first zone is located far away from the city center (the Tiananmen Square), and the other zones are in the main urban area. These nine universities are top-ranking universities in China, and seven of them are selected for the Double Top University Plan in 2015 and other two colleges are highly professional and also the leading institutions in their relative industries.

Image 1.1. The location of Dongguan Zone and city center

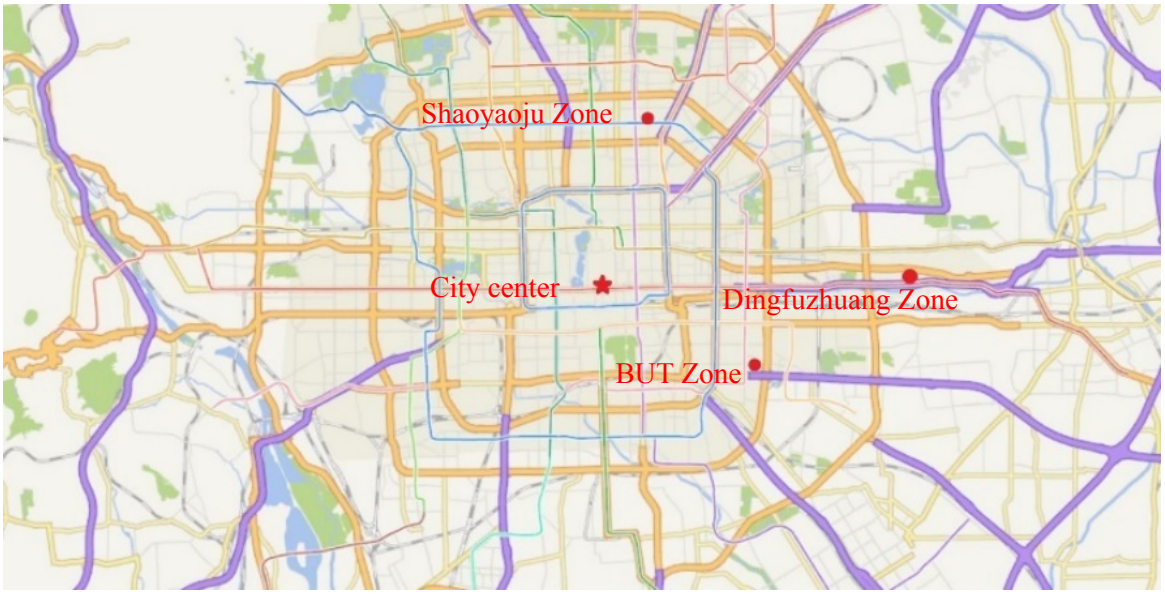

Image 1.2. The location of Shaoyaoju Zone, Dingfuzhuang Zone, BUT Zone and city center

4.2. Data collection

In this study, the data would be divided into three types of variables including structural variables, environmental variables and higher education variables relevant to the focus of this study. The database from these four zones would be provided by different resources.

The rental housing market data including structural variables would be collected from Lianjia including 10701 transactions from February 2016 to April 2018 in these 22 business districts. The transaction data contains the time of transactions, the rent price, property area, year of built, district, business district, if has subway, if in school district and lease type.

For the variable of rent price, in this case, it is observed by the company and the value is the monthly rent of a specific property.

For environmental variables, from the website of government of Beijing I could get the data of public goods including medical facilities, educational facilities and commercial facilities. For medical and educational facilities, treating them as dummy variables. If the business district owns a third-level (the highest level) hospital, a primary school, a junior high or a senior, the value of the corresponding dummy variable will be one, otherwise the value would be zero. For commercial facilities, counting number of convenience stores in the business district as the value of commercial variable. Other variables would be obtained and measured from the map website Tianditu including locational variables such as the distance to the city center and the area of business district and the environmental variables such as the green area.

Last is the higher education variables. Treating university as a dummy variable, the value of the variable would be one if there is a university or college in the business district, otherwise the value should be zero. For students, obtaining and calculating the number of students from universities' website.

4.3. Data processing

Apart from the data that could be directly observed, some other variables should be generated. Time series would be seen as a control variable to estimate whether the time of transaction have impact on the market. Due to the different size of business district, even two business districts possess the same size of green area, the impact would be different if their district size is different, so the green area ratio would be more accurate and the ratio has been used in previous studies (Wu et al., 2017). As well as the business ratio. The selected variables of the database and their definition are shown in Table 2.

Variable name	*Definition*
Time	The date of the transaction
Rent	Rent price of the transaction
Area	Area of the property
Year	Year of built
Businessdistrict	The name of the business district property located in
Zone	The zone property located in (To create dummy variable)
Bedroom	Number of bedrooms
University	Dummy, 1=with university in the business district, 0=without
Student	Number of students in the business district
Student_zone	Number of students in the zone
Hospital	Dummy, 1=with hospital in business district, 0=without
Primaryschool	Dummy, 1=with primary school in business district, 0=without
Juniorhigh	Dummy, 1=with junior high in business district, 0=without
Seniorhigh	Dummy, 1=with senior high in business district, 0=without
Greenratio (%)	Density of green area (green area/business district area)
Businessmall	Number of stores in the business district
Businessratio	Density of stores (number of stores/business district area)
Dis (km)	Distance to the city center (The Tiananmen Square)
Period_1	Dummy, 1=in the first period (before June 2017), 0=otherwise
Period_2	Dummy, 1=in the second period (after July 2017), 0=otherwise

Table 2. Variables definition

Before the estimation of regression model, data pre-processing including data cleaning and collinear possessing would be implemented and outlier should be abandoned. When summarizing the data, the dummy variable primary school, junior high and senior high have mean values that higher than 0.8 which means over 80% of property would benefit from these facilities and it would make these three variables be omitted in the regression. Generate a new dummy variable ‘Education’, it equal to one if the district has all primary

school, junior high and senior high otherwise it equals to zero.

In rental housing market, villa or big area property would be deviated so we drop the sample which has bigger than 200 square meters. And after the data processing, the overall observation is 10282 and the summarizing of variables shows in Table 3.

Variable name	*Obs*	*Mean value*	*Min*	*Max*
Rent	10282	6021.366	900	162000
Area	10282	72.627	8	200
Year	10282	1998.257	1957	2017
Bedroom	10282	1.778	1	4
University	10282	0.205	0	1
Student	10282	4911.807	0	32600
student_zone	10282	34946.63	22000	45600
Hospital	10282	0.631	0	1
Education	10282	0.710	0	1
Greenratio	10282	5.491	0	24.798
Businessmall	10282	10.210	1	17
Businessratio	10282	2.789	0.26	5.66
Dist	10282	11.887	6	37.2
period_1	10282	0.539	0	1
period_2	10282	0.461	0	1

Table 3. Summarizing of variables statistics

5. Empirical strategy

Even the hedonic pricing model has several types of functional form, few articles give the suggestions on how to choose a suitable functional form. In that case, I choose the linear model at first.

5.1. Linear regression model

As in the database, the city is divided into more than 70 business districts. Compare to political district, the business district is smaller and is mostly divided according to commercial area and subway station. The residents in the district enjoy basically the same living environment and facilities. It would be proper to use business district to segment the market.

The selection of variables in this study would base on the topic. In order to measure the relationship between higher education and rental housing market, the dependent variable would be the rent price in Beijing and the main independent variable is the higher education.

To test my two hypothesizes, on one hand, the university would be set as a dummy variable to estimate the effect of higher education. On the other hand, in order to analyze how will the scope of higher education such as the number of students and faculties affect the market, the number of students would be the variable.

Others are control variables. For structural variables, in this study the topic is about rent price while in leasing activities, renters would pay more attention to the number of rooms instead of the area of the property because they focus on whether there is a place to live instead of living better. In that case, the number of rooms would be treated as a control variable with the year of built and transaction period. For environmental variables, it contains hospital, education, business ratio and green ratio and the locational variables include the distance to the city center. And the equation of the model should be

$$R = \alpha_0 + \alpha_1 X_S + \alpha_2 X_E + \alpha_3 X_L + \beta_{HE} * \text{Higher Education} + \eta$$

where R is the rent of property, α and β are the coefficients, Xs are structural variables, X_E are environmental variables, X_L are locational variables, Higher Education is the variable of 'university' or 'number of students' and η is an error term. The Overall regression model is.

$$R = \alpha_0 + \alpha_1 \text{Year} + \alpha_2 \text{Number of bedroom} + \alpha_3 \text{hospital} + \alpha_4 \text{Greenraio} + \alpha_5 \text{Businessratio} + \alpha_6 \text{Education} + \alpha_7 \text{Distance to the citycenter} + \alpha_8 \text{Transaction period} + \alpha_9 \text{Student of the zone} + \beta_{HE} * \text{Higher Education} + \eta$$

Some common control variables in real estate analyze are not used in this model such as the transportation, subway and so on. This happens because the database lacks the specific location of each transaction and it is difficult to estimate the distance to the transportation area. If treating the transportation variable like medical and educational variables, all transaction would be located in a business district with metro station or transportation facilities.

This research would use the cross-sectional and panel data on rent market in Beijing, the quantitative method would be implemented.

5.2. Overall regression result

Firstly, run the overall regression model and get the result in Table 4.1 and 4.2.

rent	*Coef.*	*Std. Err.*	*t*	*P>t*
Year	116.4834	3.088039	37.72	0.000
Bedroom	1918.76	36.71627	52.26	0.000
university	-373.5867	67.34187	-5.55	0.000
student_zone	0.0992412	0.0027876	35.6	0.000
Hospital	-652.0885	61.74695	-10.56	0.000
greenratio	-0.2363879	5.816535	-0.04	0.986
businessratio	-76.34828	20.22039	-3.78	0.000
Dist	-158.8581	4.42032	-35.94	0.000
Education	142.7263	58.9807	2.42	0.016
period_2	368.5163	48.87391	7.54	0.000
_cons	-231311.2	6192.296	-37.35	0.000
Number of obs = 10282				
R-squared = 0.4247				

Table 4.1. Result of overall hedonic model using variable 'university'

Rent	*Coefficient*	*Std. Err.*	*T*	*P>t*
Year	117.1011	3.07265	38.11	0.000
Bedroom	1917.476	36.70316	52.24	0.000
Student	-0.0171	0.0028212	-6.06	0.000
student_zone	0.098953	0.0027776	35.63	0.000
Hospital	-664.256	61.92053	-10.73	0.000
Greenratio	-0.34344	5.805367	-0.06	0.953
Businessratio	-62.3583	20.53163	-3.04	0.002
dis	-155.61	4.534401	-34.32	0.000
Education	74.56894	63.06382	1.18	0.237
period_2	365.6852	48.86794	7.48	0.000
_cons	-232546	6161.098	-37.74	0.000
Number of obs = 10282				
R-squared = 0.4250				

Table 4.2. Result of overall hedonic model using variable 'student'

In the overall regression these explanatory variables occupy around 42.5% of the housing variance in the model. When looking through the significance of the variables, except the green area ratio with t-values of -0.04 and -0.06 and education with a t-value of 1.18 in the second regression other variables would have significant impacts on the rental housing market in these four zones at 1% level.

The marginal effect of the public goods would be derived from the coefficient of the regression model. With the increase of transaction time, built year, number of bedrooms and education, the rent price would have a positive trend. And the rent price would fall down due to surrounding hospital, high business mall ratio and increased distance to the city center.

If we look at the result using number of students as the variable, the monthly rent price would increase 117.1RMB if the property built one year later and also increase 1917.5RMB with an extra room. Transactions after July 2017 would have around 365.7RMB higher than those before June 2017 on average per month. A hospital would reduce the monthly rent about 664.3RMB while the effect of education is positive with a 74.6RMB growth. If the business ratio increases 1%, the rent price per month would decrease 62.4RMB and with 1 kilometer further to the city center, the monthly rent price would also reduce around 155.1RMB in general.

The coefficient of higher education variable is negative and significant, which means the

existence of higher education and students would have negative effect on local rental housing market. Compare to non-university business district, business district with higher education will have a 373.58RMB loss monthly and for every 10,000 students added, the monthly rent would decrease 171RMB.

While, if we look through the level of zone, with the growth of number of students and faculties the rent price would be increase. The monthly rent would be around 990RMB higher with the increase of 10,000 students. However, this value is too high and if we use the mean values of number of students in the zone and rent in the database, the increase of students in the zone would affect almost 57.4% of the rent market, it is unreasonable.

The result of higher education in the business district level is opposite to my hypothesis and there are four zones. Therefore, employing this method in each specific zone.

5.3. Regression result in each zone

Use the zone variable to divide the database into four groups and regress each group, compare to the previous model, the variable of the number of students in the zone would not see as a control variable.

5.3.1. Dongguan Zone

The result of Dongguan Zone is shown in Table 5.1.

Rent	*Coef.*	*Std. Err.*	*T*	*P>t*
Year	58.64912	3.365611	17.43	0.000
Bedroom	862.6681	40.40136	21.35	0.000
Student	0.0046445	0.0022283	2.08	0.038
Hospital	0	(omitted)		
Greenratio	7.550262	4.636924	1.63	0.104
businessratio	149.6174	23.71727	6.31	0.000
Dis	0	(omitted)		
Education	0	(omitted)		
period_2	31.24851	54.69151	0.57	0.568
_cons	-116366.7	6719.919	-17.32	0.000
Number of obs = 471				
R-squared = 0.6635				

Table 5.1. The regression result in Dongguan Zone

In the regression in Dongguan Zone, the coefficient of student is 0.0046445 which indicates that in Dongguan Zone the rent price would increase 46.4RMB with the increase

of 10,000 higher education students.

The R-squared here is 0.6635 which explain the model of about 66%. And the regression includes 471 transactions in Dongguan Zone which is the lowest in these four areas.

5.3.2. Shaoyaoju Zone

The result of Shaoyaoju Zone is shown in Table 5.2.

Rent	*Coef.*	*Std. Err.*	*t*	*P>t*
Year	164.9941	6.349446	25.99	0.000
Bedroom	2221.132	69.41798	32.00	0.000
Student	0.0174495	0.0058869	2.96	0.003
Hospital	-1281.025	243.3317	-5.26	0.000
Greenratio	137.0273	12.81304	10.69	0.000
businessratio	-569.6285	57.82615	-9.85	0.000
Dis	-687.9286	59.65822	-11.53	0.000
Education	-286.3453	147.8761	-1.94	0.053
period_2	287.6484	93.82708	3.07	0.002
_cons	-318231.6	12828.61	-24.81	0.000
Number of obs = 4748				
R-squared = 0.3766				

Table 5.2. The regression result in Shaoyaoju Zone

In the regression in Shaoyaoju Zone, it enhances the fact that the higher education factor would lead to a positive trend, with the coefficient of 0.0174495 which means a 10,000 more higher education students would bring 174.5RMB benefit in rent price. And Shaoyaoju Zone is the only area that without omitted variable.

The R-squared in Shaoyaoju Zone is 0.3766 which explains the model around 38% with 4748 transactions in this zone which is the largest amount of transactions in these four zones.

5.3.3. Dingfuzhuang Zone

The result of Dingfuzhuang Zone is shown in Table 5.3.

The R-squared here is 0.5758 which explains almost 58% of the model. And the regression in Dingfuzhuang Zone includes 3318 transactions in Dingfuzhuang Zone.

In this regression, the coefficient of higher education is negative with a value of -0.0634281 which is opposite to my hypothesis. In Dingfuzhuang Zone, the rent price would decrease 634.3RMB with increase of 10,000 higher education students.

Rent	*Coef.*	*Std. Err.*	*T*	*P>t*
Year	77.45797	2.718879	28.49	0.000
Bedroom	1436.482	26.97738	53.25	0.000
Student	-0.0634281	0.0030666	-20.68	0.000
Hospital	0	(omitted)		
Greenratio	-97.57157	7.262306	-13.44	0.000
Businessratio	922.201	44.9965	20.49	0.000
Dis	-391.5843	16.75086	-23.38	0.000
Education	0	(omitted)		
period_2	346.1056	34.86604	9.93	0.000
_cons	-147123.6	5423.673	-27.13	0.000
Number of obs = 3318				
R-squared = 0.5758				

Table 5.3. The regression result in Dingfuzhuang Zone

5.3.4. BUT Zone

The result of BUT Zone is shown in Table 5.4.

Rent	*Coef.*	*Std. Err.*	*T*	*P>t*
Year	77.08841	3.547856	21.73	0.000
Bedroom	1993.433	49.9312	39.92	0.000
Student	0.0130896	0.0055018	2.38	0.017
Hospital	0	(omitted)		
Greenratio	-18.58253	14.26946	-1.30	0.193
Businessratio	387.6876	33.14689	11.70	0.000
Dis	334.6915	64.96593	5.15	0.000
Education	0	(omitted)		
period_2	493.528	65.7197	7.51	0.000
_cons	-155699.1	7030.809	-22.15	0.000
Number of obs = 1745				
R-squared = 0.5898				

Table 5.4. The regression result in BUT Zone

The regression in BUT Zone also proves the positive relation between higher education and rent price, the coefficient is 0.0130896.

This regression contains 1745 transactions in BUT Zone and the R-squared here is 0.5898 that explains almost 59% of the regression model.

5.3.5. Comparison of individual regression

Firstly, in Dongguan, Dingfuzhuang and BUT Zone there are some control variables which are omitted due to collinearity. Dongguan Zone is in Changping District a satellite city that is far away from the city center which means Dongguan Zone is relatively independent and the number of observations is much lower than other three zones. The resources would be concentrated which reflect in the fact that all facilities including hospital, schools, universities and commercial attributes would gather in the same business districts. The distance to the city center varies slightly in this zone. With a mean value of 36.87 and the standard deviation is only 0.637. So, the variables of hospital, distance and education would be omitted in this zone. Dingfuzhuang and BUT Zone are located in the main city area and to the east of the city center. And the collinearity also happens in the variables of hospital and education in these two zones.

Secondly, if focusing on the higher education variable, in this case the number of students. All of the zones get a significant result while compare to other three zones' positive value, the coefficient of the variable number of students in Dingfuzhuang Zone is negative with a value of -0.0634. This value results in a deduction of 63.4RMB in monthly rent in the business zone where has 1000 more students in Shaoyaoju Zone on average. While the value in Dongguan, Shaoyaoju and BUT Zone indicate that the monthly rent price would increase 4.6, 17.4 and 13.1RMB with an increase of 1000 students in the business district in these three zones.

Compare the coefficient of number of students in four zones and overall regression in Table 6,

Zone	*Dongguan Zone.*	*Shaoyaoju Zone*	*Dingfuzhuang Zone*	*BUT Zone*	*Overall*
Coefficient	0.0046445	0.0174495	-0.0634281	0.0130896	-0.0171
T-value	2.08	2.96	-20.68	2.38	-6.06

Table 6. Coefficient and t-value of number of students in four zones and overall regression

Dingfuzhuang Zone owns the highest absolute value of coefficient among all zones and also the value drives the overall result with a highly significant t-value of -20.68.

Then is the control variables, for three structural control variables including built year, the

number of bedrooms and period of transaction, all the result is significant and positive which indicates that the rent price would increase on average with the increase in the number of bedrooms, the late in the year of built and the later period of transactions. While these values vary in some different zones.

The situation of environmental variables is diverse. Due to the collinearity, only in Shaoyaoju Zone the variables of hospital and education are not omitted while the result is different from the overall regression, see in Table 7.

	Shaoyaoju Zone	*Overall*
Hospital Coef.	-1281.025	-664.256
Education Coef.	-286.3453	74.56894
Education t-value	-1.94	1.18

Table 7. Coefficient of hospital and education and t-value of education in Shaoyaoju Zone and overall regression

The hospital would affect the rent market negatively in both Shaoyaoju Zone and overall model, in Shaoyaoju Zone the amount of decrease in monthly rent would be 1281.0RMB while the value would only be 664.3RMB in overall. While for education the result is opposite but both insignificant. For other environmental variables the result may only be different in one specific zone such as the impact of business ratio is only negative in Shaoyaoju Zone with a 569.6RMB deduction per month when the number of convenience store per square kilometer grows one and the impact of distance to the city center is only positive in BUT Zone with an increasing of 334.7RMB every month when the distance increase one kilometer. Meanwhile, the effect of green ratio on the market is the most complex, see in Table 8.

	Dongguan Zone	*Shaoyaoju Zone*	*Dingfuzhuang Zone*	*BUT Zone*
Coefficient	7.550262	137.0273	-97.57157	-18.58253
t-value	1.63	10.69	-13.44	-1.30
Correlation	Positive	Positive	Negative	Negative
Significance	Insignificant	Significant	Significant	Insignificant

Table 8. Coefficient and t-value of green ratio in four zones

Four zones generate four different results from the aspect of correlation and significance. On one hand, it presents positive relation in Dongguan and Shaoyaoju Zone with negative relation in Dingfuzhuang and BUT Zone, on the other hand, it shows insignificant relation in Dongguan and BUT Zone with significant relation in Shaoyaoju and Dingfuzhuang

Zone.

And with a R-squared of 0.3766, Shaoyaoju Zone owns the lowest R-squared in these four zones and except Shaoyaoju Zone the R-square in other three zones are much higher than the overall.

5.4. Regression exclude Dingfuzhuang Zone

Due to the opposite and special result from Dingfuzhuang Zone which I would analyze the result in the next section, the overall result would have some bias. In order to eliminate the impact of Dingfuzhuang Zone, the regression exclude Dingfuzhuang Zone would be implemented. The result is presented in Table 9.1 and Table 9.2.

Rent	*Coef.*	*Std. Err.*	*t*	*P>t*
Year	126.6017	4.284014	29.55	0.000
Bedroom	2139.842	52.61106	40.67	0.000
University	-43.1246	88.36405	-0.49	0.626
student_zone	-306.288	109.967	-2.79	0.005
Hospital	87.57605	7.762558	11.28	0.000
Greenratio	-236.328	28.65712	-8.25	0.000
Businessratio	-180.007	5.479451	-32.85	0.000
Dist	122.9615	78.79222	1.56	0.119
Education	262.2546	70.68171	3.71	0.000
period_2	-247833	8578.779	-28.89	0.000
_cons	126.6017	4.284014	29.55	0.000
Number of obs = 6964				
R-squared = 0.3759				

Table 9.1. Result of exclude Dingfuzhuang Zone model using variable 'university'

Rent	*Coefficient*	*Std. Err.*	*T*	*P>t*
Year	126.783	4.279594	29.63	0.000
Bedroom	2138.233	52.619	40.64	0.000
Student	-0.00526	0.003772	-1.39	0.163
Hospital	-308.112	109.8646	-2.8	0.005
Greenratio	87.37093	7.754093	11.27	0.000
businessratio	-230.265	29.01616	-7.94	0.000
dis	-178.303	5.621479	-31.72	0.000
Education	91.37013	82.19616	1.11	0.266
period_2	259.2242	70.70404	3.67	0.000
_cons	-248186	8568.93	-28.96	0.000
Number of obs = 6964				
R-squared = 0.3760				

Table 9.2. Result of exclude Dingfuzhuang Zone model using variable 'student'

These two regressions show the negative but insignificant relation between higher education and rent price, which is still opposite to my hypothesis and the individual regression in each zone.

Except education and higher education, all variables result in significant relationship. Year of built, number of bedrooms, green ratio and period of transactions are proved to be positive related while hospital, business ratio and distance to the city center are negative.

5.5. Semi-log form regression model

After using the linear form model, the R-squared in the model is around 0.425 which is not really high. In this case, the semi-log form regression model would be used. And the rent variable would use the natural logarithm form. The equation of semi-log form regression model is

$$\ln(R) = \alpha_0 + \alpha_1 X_S + \alpha_2 X_E + \alpha_3 X_L + \beta_{HE} * \text{Higher Education} + \eta$$

The overall regression model is

$$\begin{aligned}\ln(R) = {} & \alpha_0 + \alpha_1 \text{Year} + \alpha_2 \text{Number of bedroom} + \alpha_3 \text{hospital} + \alpha_4 \text{Greenraio} + \alpha_5 \\ & \text{Businessratio} + \alpha_6 \text{Education} + \alpha_7 \text{Distance to the citycenter} + \alpha_8 \\ & \text{Transaction period} + \alpha_9 \text{Student of the zone} + \beta_{HE} * \text{Higher Education} \\ & + \eta\end{aligned}$$

5.5.1. Result of semi-log model

Run the overall semi-log regression model and are shown in Table 10.1 and Table 10.2.

Rent	*Coef.*	*Std. Err.*	*t*	*P>t*
Year	0.016927	0.000268	63.22	0.000
Bedroom	0.277354	0.003184	87.12	0.000
University	-0.061381	0.005839	-10.51	0.000
student_zone	0.000013	2.42E-07	55.39	0.000
Hospital	-0.093022	0.005354	-17.38	0.000
Greenratio	0.001161	0.000504	2.30	0.021
Businessratio	-0.000907	0.001753	-0.52	0.605
Dist	-0.028402	0.000383	-74.10	0.000
Education	0.006900	0.005114	1.35	0.177
period_2	0.063690	0.004238	15.03	0.000
_cons	-25.79489	0.536907	-48.04	0.000
Number of obs = 10282				
R-squared = 0.6926				

Table 10.1. Result of overall semi-log model using variable 'university'

Rent	*Coefficient*	*Std. Err.*	*T*	*P>t*
Year	0.016998	0.000266	63.95	0.000
Bedroom	0.277171	0.003175	87.30	0.000
Student	-3.14E-06	2.44E-07	-12.88	0.000
student_zone	0.000013	2.40E-07	55.67	0.000
Hospital	-0.096190	0.005356	-17.96	0.000
Greenratio	0.001040	0.000502	2.07	0.038
Businessratio	0.001874	0.001776	1.06	0.291
dis	-0.027709	0.000392	-70.64	0.000
Education	-0.008000	0.005455	-1.47	0.143
period_2	0.063083	0.004227	14.92	0.000
_cons	-25.9349	0.532939	-48.66	0.000
Number of obs = 10282				
R-squared = 0.6942				

Table 10.2. Result of overall semi-log model using variable 'student'

From this semi-log model, we can see that these explanatory variables occupy around 69.4% of the housing variance in the model with the value of R-squared around 0.694. When looking through the significance of the variables, the absolute values of t-value of

businessratio and education are lower than 1.96, which means the convenience stores and educational facilities would not have significant impacts on the rental housing market in these four zones at 1% level.

From the result we can prove that the rent price would increase with the later transaction period and built year, the increase of number of bedrooms, green ratio and business ratio because of their positive coefficients. While the marginal effect of hospital, distance to the city center and education is negative with the coefficients lower than zero.

When looking at the result using the dummy variable 'Student of the district' as the main variable, the monthly rent price would grow almost 1.70% if the property built one year later while an extra bedroom will bring 27.72% increase. Time period would also affect the price, compare to the first period (before June 2017) the monthly rent after July 2017 grows around 6.31%. A hospital would reduce the rent price about 9.62% and the education would reduce 0.80% with an insignificant impact. If the green ratio increases 1%, the rent price would increase 0.19% per month and the business ratio would have a negative effect with the coefficient of -0.008%, while the impact is insignificant. At last, with 1 kilometer further to the city center, the monthly rent price would also reduce 2.77% in general.

As the same as the linear regression model, the coefficient of higher education variable is negative and significant, which indicated the negative relation between the higher education or students and local rental housing price. Compare to non-university business district, business district with higher education will have a 6.14% loss in monthly rent and for every 10,000 students added, the monthly rent would decrease 3.14%.

While, if we look through the level of zone, as same as the linear model, with the growth of number of students and faculties the rent price would be increase. The monthly rent would be around 13% higher with the increase of 10,000 students.

5.5.2. Comparison of two forms of model

By using these two forms of model, the linear model and semi-log model. The results are diverse. The result of relationship between rent price and variables are shown in the Table 11.

Rent	*Linear model*	*Semi-log model*
Year	+	+
Bedroom	+	+
University	−	−
Student	−	−
student_zone	+	+
Hospital	−	−
Greenratio	− (insignificant)	+
businessratio	−	− (insignificant)
Dist	−	−
Education	+ (insignificant)	+ (insignificant)
period_2	+	+

Table 11. Result of relationship between rent price and variables

From the table we can see that for the variables such as built year, number of bedrooms, university, student of the business district, student of the zone, hospital and distance to the city center, the results of these two regression models are the same with significant effect. For the education, both models predict a positive while insignificant relation. For the green ratio, in linear model the result is negative but insignificant whereas the result is positive and significant in the semi-log model. And for the business ratio, both models give a negative relation but in the linear model the relationship is significant while an insignificant result presented from semi-log regression.

Another method to compare two models is to compare two R-squared. However, the comparison R-squared only work when the dependent variables are in the same form. In that case, obtaining the antilog predicted values is the method to fix the question and then running the regression and calculating the R-square between the observed linear values and predicted linear values. The result is in Table 12.1 and Table 12.2.

Ln_renthat	*Coefficient*	*Std. Err.*	*T*	*P>t*
Rent	0.0000638	7.43e-07	85.78	0.000
_cons	8.236215	0.0050793	1621.53	0.000
Number of obs = 10282				
R-squared = 0.4172				

Table 12.1. Regression of antilog of the observed and predicted values using variable 'university'

Ln_renthat	*Coefficient*	*Std. Err.*	*T*	*P>t*
Rent	0.0000639	7.44e-07	85.83	0.000
_cons	8.235645	0.0050841	1619.88	0.000
Number of obs = 10282				
R-squared = 0.4174				

Table 12.2. Regression of antilog of the observed and predicted values using variable 'student'

By using 'university' and 'student' as main variable individually, these two regression models contain 10282 samples with R-squared value of 0.4172 and 0.4174. Compare to the R-squared in linear regression, the R-squared is lower in the predicted semi-log regression, so in this study, using linear model is better in the overall regression. And the comparison of R-squared in two models is shown in Table 13.

R-squared	*Linear model*	*Predicted semi-log model*
'university' as variable	0.4247	0.4142
'student' as variable	0.4250	0.4147

Table 13. R-squared comparison in two models

And when implementing the predicted semi-log regression in four zones, they also show the same result as the R-squared are lower than those in linear model.

6. Discussion

6.1. Discussion on higher education

In the section of empirical strategy, by testing the overall regression model and regression models in four zones, the results have shown different estimations. In my opinion, these deviations could be explained by several reasons.

For the impact of higher education, the overall model and Dingfuzhuang Zone show a negative relation while in other three zones the coefficients are positive. Dingfuzhuang Zone drives the overall result and it could due to two reasons.

First reason is the level of the university. Zhong et al. (2018) indicated that the first-tier university would have significantly higher prices effect on the market, while the second-tier and third-tier universities do not. In 2015, the Chinese government set a Double First-Class University Plan, and universities in this plan could be seen as the first-tier university in China.

As shown in Table 14, all universities in Dongguan and BUT Zone can be treated as first-tier university, and 75% of universities in Shaoyaoju Zone is first-tier university while only half of the universities in Dingfuzhuang Zone is first-tier university.

	University	*Proportion of first-tier university*
Dongguan Zone	CUP (first-tier), CUPL (first-tier)	100%
Shaoyaoju Zone	UIBE (first-tier), BUCM (first-tier), BUCT (first-tier), BIFT (second-tier)	75%
Dingfuzhuang Zone	CUC (first-tier), BISU (second-tier)	50%
BUT Zone	BUT (first-tier)	100%

Table 14. Universities and their tier in four zones

Another reason is Dingfuzhuang Zone is located between the city center and the new government center area, in Figure 2.

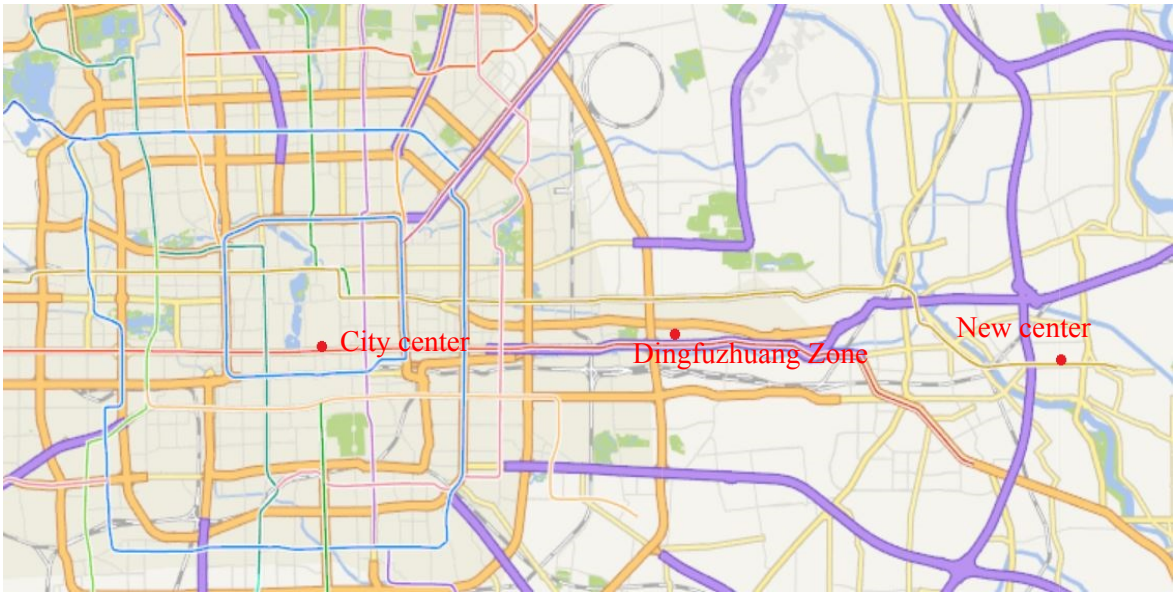

Figure 2. The location of Dingfuzhuang Zone and two city centers

The higher price index in two center area make Dingfuzhuang Zone a price low-lying land. And even Dingfuzhuang Zone is close to the city center there is still large amount land not yet developed, especially in the business district Shuangqiao and Changying. This situation and location may stimulate low-income renters cluster in this zone, see in Table 15.

	Shaoyaoju Zone	*Dingfuzhuang Zone*	*BUT Zone*
Mean value	7350.84	5032.93	5621.74

Table 15. The mean value of rent in Shaoyaoju, Dingfuzhuang and BUT Zone

Compared to other two zones located in main city, Dingfuzhuang Zone has the lowest mean value of the rent. And it would affect the regression in Dingfuzhuang Zone.

6.2. Discussion on other variables

For the commercial and medical attributes, the effect varies from place to place, while in this study we choose the third-level (the highest level) hospital and get the negative values in every regression. This situation can be explained that large hospital always accompanies large number of patients, crowed traffic and a lot of noise. Moreover, Beijing owns numerous best hospitals in China including Anzhen Hospital in Shaoyaoju Zone. These hospitals would not only serve local residents, but also give service to citizens from all over the country. Thereby aggravating the situation.

For the distance to the city center, only in BUT Zone the variable would affect the rental housing market positively, which means in BUT Zone the rent price would increase with further to the city center. The urban expansion could to some extent explain the situation.

	BUT	*Jinsong*	*Panjiayuan*	*Huawei Bridge*	*Huanlegu*
Mean value of Year of built	1997	1991	1997	2000	2005
Distance to the city center	7.82	6.02	6.42	7.92	9.58

Table 16. The mean value of year of built and distance to the city center of five business districts in BUT Zone

In Table 16, we could see the city expand from 1991 to 2005 in BUT Zone. The average age of the property in furthest business district is 15 years younger than the value in the closest business district, and that could explain the negative relation between distance and rental housing market in BUT Zone.

7. Conclusion

In recent years, higher education grows rapidly in China. The number of universities and college students has increased year by year. With the city expansion, the government needs universities to gather popularity in suburb or new city area, meanwhile, universities also need land and facilities to promote their own development. These two powers stimulate more and more universities start to build new campus in suburb or new city area. Along with the new supply from students and faculties due to improved requirements of living environment or increasing enrollment rate and high-quality amenities provided by the university campus, the capitalization of high education could not be neglected.

This study provides the capitalization of higher education in rent price in Beijing to a certain extent. It indicates that the relationship between higher education and rent price would vary. The positive relation exists in three zones of my study, while the only one remaining zone which is Dingfuzhuang Zone has reached an opposite result which I could attribute to the quality of target universities and the location of the remaining zone. While the overall impact of higher education is difficult to measure due to its insignificant results.

Even the result is complex and insignificant, it is really important to measure the relationship between higher education and rent price. With the university campus expansion and population growth, university campus is bound to have an impact on the rental market.

On one hand, the government should consider the amenities that the university campus would bring for its neighbor such as library, stadium, subway station and so on. And will the surrounding real estate price have obstacles to introducing talents in the university?

On the other hand, the government should also think over the implementation of public rental housing policy. Where is the best location for public rental housing? How to meet the needs of tenants living? How will the university campus affect the willing or life experience of tenants? And how to achieve economics and maximize benefits.

8. Limitation and future study

In this study, there is still have some limitations related to database, method and so on.

Firstly, the database should be more accurate and comprehensive, this study uses the transaction data from February 2016 to April 2018 in Beijing rental market. However, when looking through the year of built in data base, only 28 properties were built after 2015 and even there is no transaction data about property built in 2016. Meanwhile, there are almost 3.4% of samples lack the information on the year of built, in some business district the value accounts for 10%. And the database also lacks of information on some key elements including floor to area ratio and property greening rate.

Secondly, in this study, due to the lack of specific coordinates the proximity of some environmental attributes including hospital and education are treated as dummy variables instead of using the distance between the facilities and properties. This choice may bring bias, especially in some large or with irregular shape business districts. Different property in the same business district may benefit differently from the same attribute.

Other control variables such as distance to the metro station could be included in this model if the coordinates can be obtained.

Thirdly, green area ratio is calculated by dividing the area of parks and squares by the area of the business district in this study. However, in China, the green area ratio is treated as a structural facility. The government would have specific requirement of green area ratio for each property project, the green area here is based on the property itself.

If the green area ratio of each property could be gotten, the park and square could be treated as an environment variable and as the same variables as hospital and education. So, in this study, the green ratio would not have significant effect on rental housing market.

Finally, the scope of university should be expanded. In this study, the nine chosen universities are first-tier universities in China, while none of them is top-ranking university.

As previous study showed the first-tier university would affect the housing market positively, the future study could focus on the effect of different tiers of higher education.

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