Land Values Impacts of Subway Stations

A case Study of Beijing City

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2012/5/4

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Abstract

This paper reviews researches regarding the impacts urban rail transit system on real estate development and examines the subway system in Beijing, China. Using land transaction prices published by Beijing Land Consolidation Reserve Center, the author finds that the existing subway stations indeed enhance property value of nearby lands. While there is no obvious difference among various kinds of transaction modes, such as invitation of bid, listings for sales and auction, the typology of stations actually plays an important role in affecting the land market. For stations being located within important business districts and inner city, their power of attracting ridership and promoting adjacent land value are much higher than those in suburban area. In general, these results suggest that subway system is indeed one major promoter for land market in the City of Beijing.

1. Introduction

Transportation has been among the most critical aspects of modern planning. Transit-related planning is connected with many other issues, such as working opportunities, mode choice for commuting, housing choice, real estate development, and so on. All of them are highly valued by most informed citizens. Also, people's preference towards certain types of transportation planning to a great extent determines how the city is shaped and how humans interact with the place they reside on. Take urban sprawl as example, automobile oriented planning, combined with the prosperity of auto industry, has influenced most people's life style. Entirely unimaginable before it began, urban sprawl was one of the most painful challenges in American planning history – so much so that it is now impossible to imagine what it would have been like without it. So the attention devoted to the relationship between transit related planning and land use pattern has always been a popularly academic field.

In this context, the author puts the focus on subway stations' impacts on nearby land values. Study area is centered on urbanized Beijing, China. One major reason is that Beijing is the densest city in a nation of 1.4 billion populations. Subway system is thus perceived by many as a greatly helpful instrument and expected to impose significant leverage on the value of nearby real estate projects.

The remainder of this paper is organized as follows. Next section reviews some previous studies, being followed by an introduction to the study area and the history of Beijing Subway System. Methodology being used and data source is then delineated. After that is a section about regression analysis and major findings. Final part presents key lessons learned based on the regression model and special land use policy in China.

2. Previous Research

The effects of rail transit system on urban land-use have been examined by many studies. Emerged as an important transportation alternative, public transportation in general – and rail transit more specifically – is frequently justified by its advocates on social, economic, and environmental grounds (Huang, 1996). Rail transit systems affect land use value through altering people's travel pattern and their preference on house choice. For the city as a whole, large transit project, such as subway system, is likely to determine the shape and the operation of the city.

2.1. Alleviation of Urban Congestion

Having been dominated by private automobile and suffered from the negative consequences of mass auto-use, federal, state, and local government of the United States spend billions of dollars to build and maintain rail transit system. Transportation planning as a discipline has struggled to correlate travel behavior with accessibility to transit service and housing property values. Studies show that developers pay a certain amount of money based on the location of the land. One dominant factor explaining the difference between land (property) values was the accessibility as measured by the distance to the Central Business District (CBD) and the associated transportation costs (Debrezion, Pels, & Rietveld, 2006). Indeed it is flourishing area of people's primary goal and concerns. Transit's role is in the provision of means by which people get to desirable destinations. In a city where automobile cannot fluently take people to whatever they want to go due to severe congestion, investment in transit infrastructure, such as subway system, becomes an alternative reducing the actual distance between people and location. As a result, it can be expected that a price curve will have a negative slope; when moving away from the station, prices decreases (Debrezion et al., 2006).

Because the construction of rail transit system takes a relative long time and housing market does not always react instantly, there are debates on when transit stations actually start to promote values of property in close proximity. In a study examining the pre-service impacts of Vancouver's advanced Light Rail Transit (ALRT) system on single-family property values during the period from 1971 to 1983, Fergusan and Goldberg found that land values nearby increased approximately three years after the station locations were announced and one year after the ALRT system began operation (Fergusan, Goldberg and Mark). In another case, by having employed a large sample of single-family house sales as well as both the repeat-sales method and the hedonic method to estimate the impact of the Chicago Midway Line on house prices, McMillen and McDonald find that the housing market are greatly affected by the proximity to the stations. Moreover, this influence can be anticipated several years prior to the opening of the new line. The Midway Rapid Transit Line opened in Chicago on October 31, 1993, but the house price gradient did show up 6 years before (McMillen & McDonald, 2004).

For our study focusing on the City of Beijing, we cannot confirm the exact time when the station location was announced. In a politic regime where real estate developers have more intimate relationship than it should be with local government, it is even more difficult to pin down when a new subway line exert influence over land values.

2.2. Nuisance Associated Rail Stations

While there is widely accepted idea about the existence of a positive relationship, research results are mixed. As indicated in a research on assessing MARTA rail transit station's impact on residential property values, Bowes and Ihlanfeldt find that not all types of transit factors affect property value in a same direction. A total of four factors can be identified – two which may cause higher property values and two

which may cause lower property values in station area. Noise, pollution, and the unsightliness generated by the stations counter the positive impact on property (Bowes & Ihlanfeldt, 2001). This section will talk about disadvantages regarding various income levels.

Gentrification

Transportation can be related to poverty alleviation through economic growth that increases labor market opportunities for the poor (Boarnet, 2007). In the sense that transportation system is able to connect different places and weave the city together, emergence of new rail transit is widely perceived as paths to opportunities for low-income people. However, two impedances stand in the way. For the first place, transit tickets are not always affordable to the poorest. In many cities, operation expenses are supported by state funding and ticket sales, so the price has to be designed carefully. In a research studying BRT in Colombia, Munoz-Raskin found that taking BRT are more convenient as well as more expensive than taking paratransit (Munoz-Raskin, 2010). Constrained the budget, people cannot afford the BRT price are actually excluded from this supposedly public-intended system, no matter how close the station is to the place where people reside. To ensure equitable treatment, a wide range of policies aimed at making public transport "affordable" to poor household, which invariably imply some types of subsidy to benefit these individuals, are implemented (Serebrisky, Gómez - Lobo, Estupiñán, & Muñoz - Raskin, 2009).

A second equity-related issue involves gentrification. Transportation investment is an important indicator of housing choice. Rail transit is generally held as a promoter for economy and property value of most nearby houses. Research has shown that people in congested area are more likely to move into community where transit stations are in its proximity. If the community was preoccupied by relative poorer residents, the new property owners may raise rents to the extent that original hosts have to move to other cheaper

locations. Some researchers argued that gentrification is at least in one sense appropriate as a part of a larger redevelopment process (Smith, 1982). But the poor are already driven away and excluded from the area to be redeveloped.

Crime Attractors

As to the high-income housing market and communities, the proximity to rail stations is sometimes considered as a disadvantage. Planning authorities should take into account the value discounts associated with stations crime (Munoz-Raskin, 2010). On December 22, 1984, Bern Goetz, a white male passenger of New York City Subway train triggered his revolver five times and shot four young African American who tried to rob him. This case occurred during a period of increasing crime rates in New York City. It not only dominated the nation's media, but also led to public reflection on urban crime and racial issues.

In their studies focused on crime incidence on and around rail line stations, Loukaitou-Sideris et al found that the busiest stations tended to concentrate the most serious crime (Loukaitou-sideris, 2002). Transit stations are truly public spaces mingling different kinds of users every day. Offenders can linger around anonymously to locate tired or preoccupied target (Block and Sean, 1996). A more essential reason is that rail stations may be the densest area of this planet. Beijing is the political hub of a nation with nearly one point four Billion people. In this extremely crowed area, where it is almost impossible for passengers to keep their eyes on all the belongings simultaneously, purse snatching happens. Other environmental nuisances such as noise also constitute a factor decreasing values of property in close proximity to rail stations

2.3. Hedonic Pricing Methodology

Only distance gradient is far from the whole story. Many factors other than proximity to transit stations also determine land use types and values. Land use factor interact with transport in a mutual manner. Litman in his report includes some features as individual land use factors, such as regional accessibility, density, centeredness, land use mix, connectivity, roadway design, walking and cycling condition, transit accessibility, community cohesion, and so forth (Litman, 2011).

As early as 1974, Rosen introduced hedonic pricing methodology based on the idea that a class of differentiated products is completely described by a vector of objectively measured characteristics (Rosen, Journal, & Feb, 1974). This method provides a feasible means of explaining what kind of socioeconomic features can lead to the difference of land property values. Since then, researchers have incorporated more and more factors trying to generate comprehensive model to explain the land and housing property values.

Take one study on land value impacts of rail transit services in Los Angeles County as example, two set of factors are being used for analysis. The first one is called “transportation proximity measures”, which is set as dummy variable to indicate whether property is located within 1/2 mile of station or not. The second set is about property and location attributes, including structure size, lot size, structure year, population density, employment density, household income and the location of political center of the City of Los Angeles. In another study focusing on housing price dynamic in Boston, Massachusetts, property values are assessed against the changes in demographics, supply of new housing, distance from the CBD, employment in the manufacturing sector, and aggregate school enrollment (Case & Mayer, 1996).

3. Conceptual Framework

Based on the previous study, we used land transaction price as indicators of land property values and examined factors that are likely to affect the price. Figure 3.1 briefly shows how the factors are incorporated to explain and predict the values of land property. The rectangle with dash line as boundaries includes parameters being considered in the regression model, such as land use types, degree of infrastructure provision, intensity of land use, proximity to subway stations, and the time when the transaction is issued.

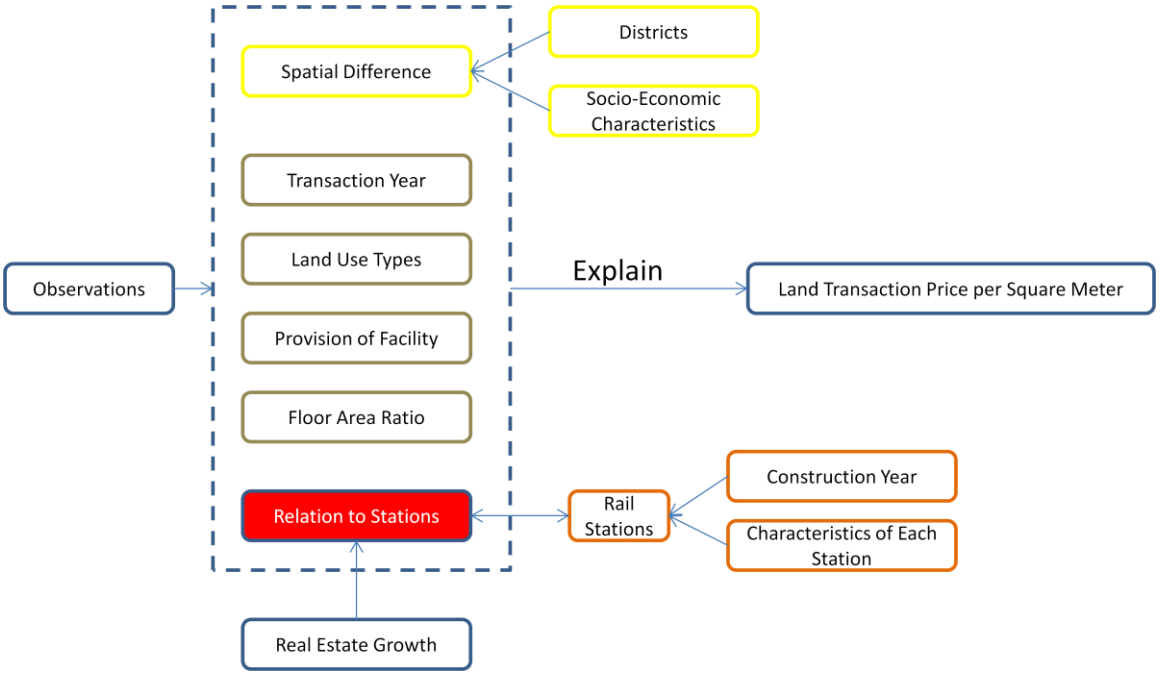

Figure3. 1: Conceptual Framework of the Research

Because Beijing is a huge city with an area over 6,000 square miles, mechanisms through which rail stations affect land value are supposed to vary dramatically across the city. As is shown the yellow rectangle, a set of districts is introduced to exclude control socio-economic characteristics that are associated with each district. Figure 3.2 shows the distribution of districts of Beijing City. Since our transaction records are located in only 13 of all districts, 12 dummy variables of districts are used in the model.

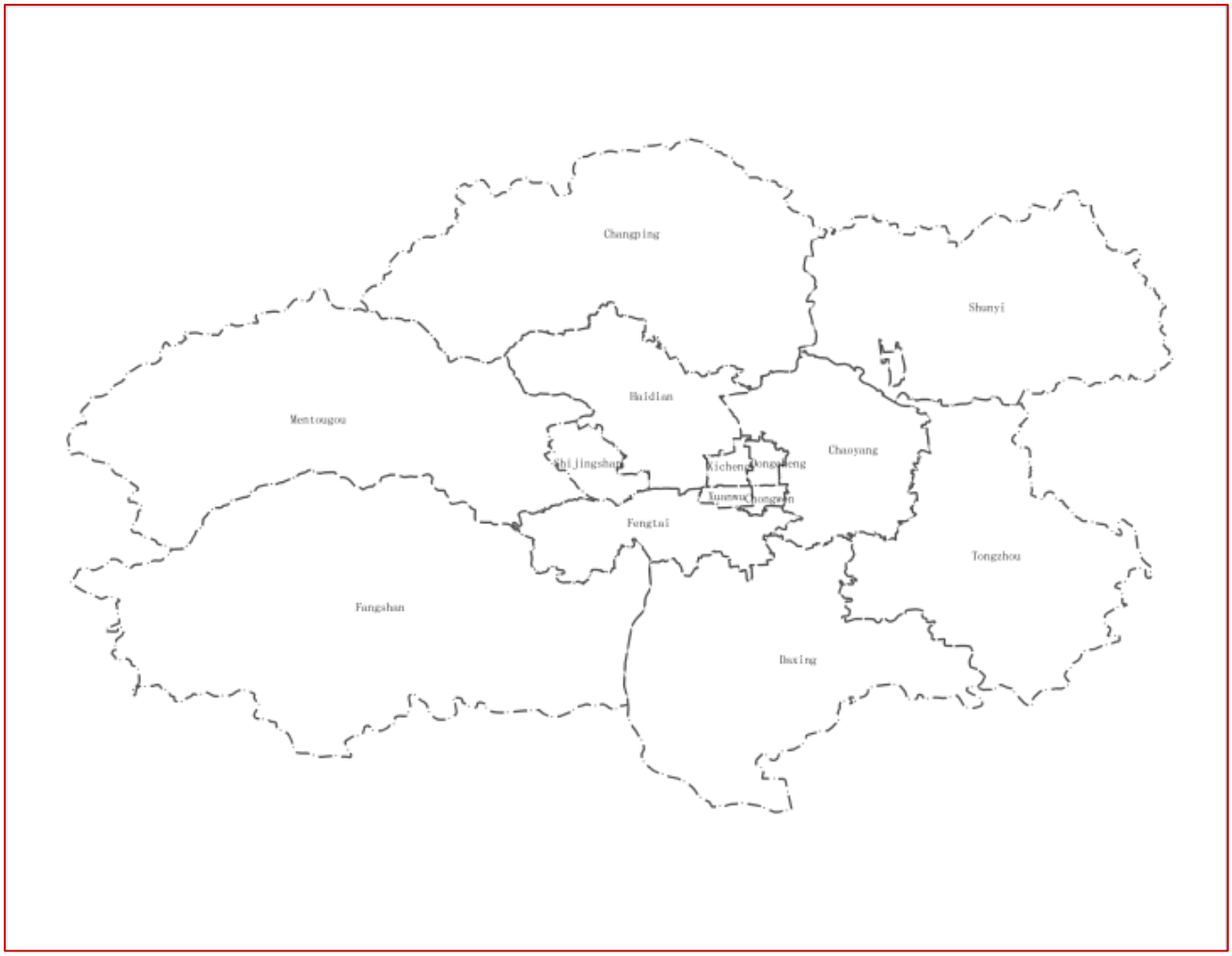

Figure3. 2: Beijing Districts

Besides adjusting district variance, in a second model adjustment we took into account the indigenous characteristics of different stations. As has been mentioned before, we are not sure when the stations start to exert their influence on housing market, so we assume that real estate developers consider only the existing rail lines and stations when purchasing lands. For model design, we further differentiate stations based on the location where they fall inside. For example, stations in central business area tend to be more positively related to land price than those located in suburban area. While political districts are delineated with clear boundary, the spillover effect of business center tends to be more continuous throughout the whole city. For that reason, we substitute dummy variables of stations types for district dummy in the second method.

4. Context

As the capital of the People's Republic of China, Beijing lies on the northeastern margin of the North China Plain. The city is characterized by its high land value and dense population. In 2010, population of Beijing City is approaching 20,000,000, which is almost twenty times the Fulton County population for the same period. Latest release of 2010 census indicates only 920,581 people within the whole Fulton County. Such big amount entails correspondingly large amounts of commuting trips. Surface transit is facing an out-of-control expansion of car demand and witnessing nearly 1,500 new cars to its notoriously congested roads. Widely accepted by most citizens, Beijing subway system has received rapid development in order for addressing congestion problems. Although for the past decade the system has grown in an incredible speed, its beginning was really tough and full of challenges.

Ideas of constructing subway to enlarge Beijing's mass transit capacity were proposed as early as 1950s. After the Korean War, much attention was drawn back to domestic development and some defense fortification. So the planned subway was intended for both military and civil use. However, China was just recovered from the World War Ⅱ and the civil war against with Nationalist Party, and was with little experience on Constructing subway. Transit engineers from Soviet Union were invited to help generate subway planning. Unfortunately the cooperation didn't last long enough. Political relationship between China and Soviet Union got worse in late 1950s, leading to the withdrawing of foreign experts and a sudden halt to subway projects.

Then Chinese architects took the lead and restarted the subway construction on July, 1965. This was a tough beginning because some major controversies were associated. The first one is on whether the construction can run through the central district and demolish the inner city wall for making way. While some chief politic leaders preferred the transit development over city wall, leading architect like Liang Sicheng focused on the

importance of this historic landmark and tried every means to protect it. The debate over preservation of historic structure and modern development was nothing new then. And eventually some parts of the wall persisted thanks to the effort of the Premier and many other scholars. Another concern pertains to the ownership of the subway system. In a country where central government holds relative high political power, the State claims its control on almost every giant and valuable goods. Subway, which should be substantially non-rival and non-excludable, is more of one kind of public commons. Role of transit agencies and government require providing the public with quality service on an equal basis for riders. However, during the early year of the operation, Beijing subway were under the control of the People's Liberation Army and opened to only those with riding permit from their work units. People with less income and lower social status were unlikely to benefit from this rapid transit, resulting in evident inequity issues.

After decades of slow improvement, Beijing subway system receives rapid expansion from 2000 till present. There is strong evidence that constructing subway for the purpose of promoting economy and relieving congestion in surface transit is becoming a decided trend. All but two of Beijing Subway's 15 lines were built in this period. Stimulated by the success of winning the bid to host the 2008 Summer Olympics Game, large amounts of funds and efforts are put into the comprehensive subway projects, resulting in 9 new open lines. The development is not limited to only central urbanized area. Several routes are also built to connect the suburbs and political hubs in the core. Figure 4.1 in the below shows that overall 14 routes are running across the whole city, with a total track length of 336 km. The system ranks fourth worldwide, following those in Metro of Shanghai, London and New York.

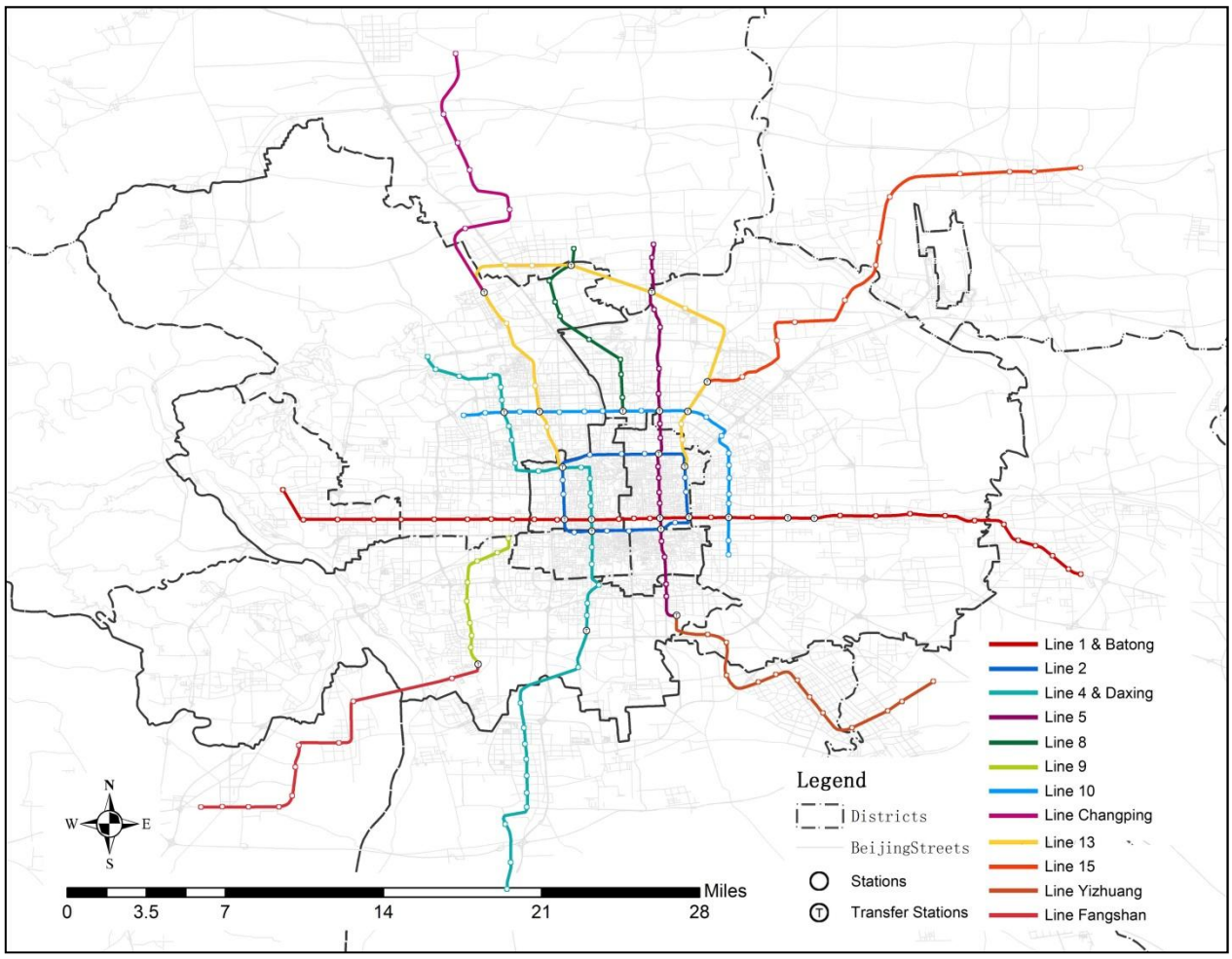

Figure4. 1: The Beijing Subway System[1]

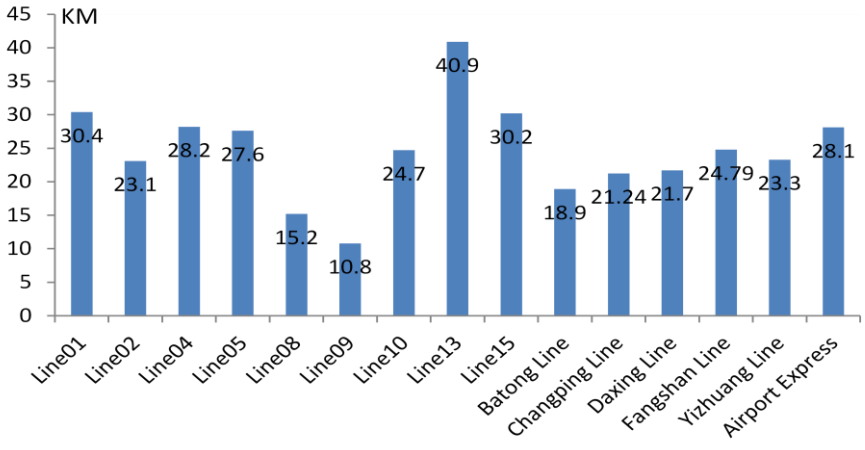

Figure4. 2: Length of the Subway Lines

Among those railways, line 15, Changping, Fangshan and Yizhuang was opened after the Olymic Game.

[1] Street Date: Openstreet web site. http://www.openstreetmap.org/; Stations Location Data: Google Maps.

Moreover, about 7 new routes are scheduled to be opened in the next few years, featuring a significant expansion of subway's coverage in Beijing. Given the status quo of surface conjestion, the subway system is expected to carry heavy regional traffic and meet people's huge demand for commuting. When compared to cars and other modes of surface transportaion, in-vehicle time spent in subway is relatively stable and sometimes less. By living closer to rail stations, people are able to reduce the overall commuting time to a large extent and thus appreciate the proximity to stations when making housing choices.

5. Data Description

5.1. Original Data Sets

This research is enabled by the availability of land transaction data published by Beijing Land Consolidation Reserve Center. Data is provided in a year to year base in an open website where anyone can access to it. Those we use include all sales transactions of land within the municipality boundary from 2004 to 2011. Table 5.1 shows the original attributes associated with each land parcel sold. In the database each record represents one transaction, consisting of total area, construction area, area for public infrastructure, land use types, level of existing infrastructure, developers, and other information.

Table5. 1: Origin Data Input

Original Data: Table 2004_2011	
Field Name	Definition
TransaID	Unique identifier of each transaction
PriceFinal	Land transaction price (10,000 yuan)
PriceStart	Initially announced price (10,000 yuan)
Price_Floorarea	*PriceFinal*10,000/AreaFloor (yuan per square meter)*
AreaTotal	Total area (square meter)
AreaLandBuilding	Total area of land used for construction (square meter)
AreaSub	Area of land to be occupied for constructing public infrastructure
AreaFloor	Total floor area of construction on the land (square meter)
FAR	Floor area ratio: *AreaFloor/AreaLandBuilding*
LandUse	Land use types in Chinese
LandUse2	Land use types in English
Facility	Level of infrastructure provision
TransMode	Mode of transaction
AuctionTimes	Times of auction
Year	Year when each land is transacted
SDate	Auction beginning time
EDate	Auction ending time
Name	Name of the project
Address	Address of the lands
Developers	Buyers of lands

5.2. Derived Data

Besides, other data were obtained based on the relationship between each land parcel and its geographical characteristics, including distance to a nearest rail station, land use types, year when it was transacted, districts that it belong to, and the degree of infrastructure provision.

Table5. 2: Derived Data

Independent Variable		
Attribute	Definition	Note
distoD	Distance to Station	
distoC	Distance to Subcenter	
Land Dummy		
L_Commercial	1 if commercial land	
L_Residential	1 if residential land	Dummy for land use types, bench: mixed use
L_Others	1 if other land use types	
Year Dummy		
Y2005	1 if year 2005	
Y2006	1 if year 2006	
Y2007	1 if year 2007	
Y2008	1 if year 2008	Dummy for year, bench: year 2004
Y2009	1 if year 2009	
Y2010	1 if year 2010	
Y2011	1 if year 2011	
Transmode Dummy		
T_Listings	1 if Listings of Sales	
T_Auction	1 if Auction	Dummy for Transaction modes, bench: invitation for bids
District Dummy		
D_Changping	1 if Changping District	
D_Chaoyang	1 if Chaoyang District	
D_Chongwen	1 if Chongwen District	
D_Daxing	1 if Daxing District	
D_Dongcheng	1 if Dongcheng District	
D_Fengtai	1 if Fengtai District	Dummy for District, bench: Fangshan District
D_Haidian	1 if Haidian District	
D_Shijingshan	1 if Shijingshan District	
D_Shunyi	1 if Shunyi District	
D_Tongzhou	1 if Tongzhou District	
D_Xicheng	1 if Xicheng District	
D_Xuanwu	1 if Xuanwu District	
Facility Dummy		
F1	Low Level	Dummy for facility, bench: others and least level of provision

F2	Medium Level
F3	High Level

5.3. Criteria of Data Selection

On the outset the original records amounted to 1197, but based on our data selection criterion and the quality of supportive data, we kept 413 out of all for further analysis. A very first criterion is to exclude all industrial lands, whose price is less likely driven by normal housing markets. Fundamental reason lies in China's unique land regulatory regime, where local governments are de facto owners of all urban land within their jurisdictions. They have absolutely control over urban lands, being able to determine which land can be transacted and how the revenue is to be distributed. Given this monopoly power, local governments are able to develop various strategies for transaction of industrial lands and business lands.

Demand for commercial and residential lands, it is often argues, are highly related with choice of locations. People choosing a place to live are sensitive to many location specific characteristics, such as proximity to jobs, existence of high-performing schools, lower crime rates, etc. Given the limited land supply, real estate develops are willing to rush into an economically prosperous city like Beijing and compete for land leases. In this sellers' market, government can use their leverage and local monopoly to exact maximum rent from benefit driven enterprises. Industrial lands, on the other hand, benefit a municipality through generating considerable job opportunities and continuous GDP growth in the long term. Besides, industrial sector usually spawns both upstream and downstream industries, which also contribute business tax to local government. From a revenue perspective, manufacture enterprise are ubiquitously desirable. However, manufacturers don't have to be located in any specific city. In this sense, local governments have to compete for manufacture investor and lease industrial land at a relative lower price, leading to a buyers' market.

By virtue of local monopoly, governments intentionally depress the land price to a degree far less than normal market rate. Factors that affect market value of residential and commercial lands do not apply to industrial land well. For example, proximity to transit station reduces people's commuting time and opportunity cost, making people appreciate residential land nearby.

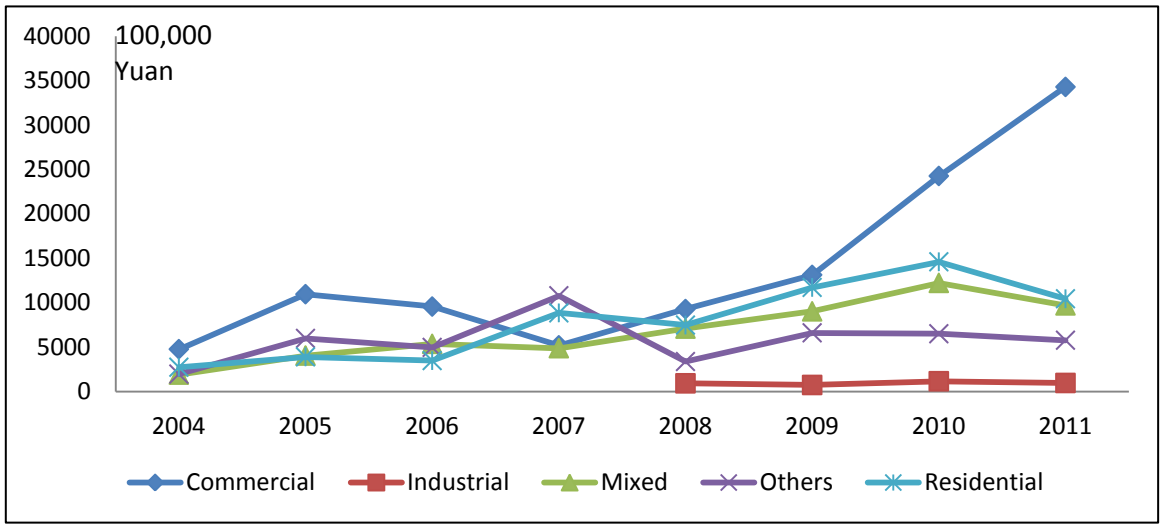

Figure5. 1: Trend of Average Price for Various Land-use Types

Figure 5.1 displays trend of average price for various land-use types from year 2004 to year 2011. Industrial lands are represented by red dots, lying at the bottom of the figure. No matter what fiscal year it is, industrial lands are significantly cheaper than any other types of lands. While subway system undertakes the task of carrying people, rather than cargo or raw materials, industrial lands do not affect daily commuting pattern so much as commercial or residential lands. So in our study trying to figure out the connection between subway stations and land use values, we exclude industrial land from the regression model.

Other records being ignored include those cannot be spatially located or locate far away from the central district. Although some lines are already opened for connecting the suburban and the central area, there is still plenty of low-density area where no station can reach. For transactions that occurred in these remote places,

they are unlikely to be affect by subway construction either. Eventually we end up with 413 transactions records, which will be discussed in more details later.

6. Hedonic Analysis

6.1. Basic Specification

Our first step was to test a simple OLS model, which did not account for the districts variance and the fact that different types of stations function differently. Except for the variable showing how far away a land transaction is from its nearest stop, all others are derived from the official transaction announcement.

This first model is summarized as:

$$Ln(price) = \alpha + b_1 Ln(distoS) + b_2 FAR + L_i + M_t + Y_j + \varepsilon \quad (1)$$

where Ln(price) is the natural logarithm of land price per square meter; FAR is floor area ratio; Ln(distoS) is the natural logarithm of distance from land parcel to its nearest subway station; L_i = a dummy variable that equals 1 if the land parcel is categorized at mixed use; M_t = a dummy variable set to 1 if the land is transacted by means of invitation to tender; Y_j is a dummy variable that equals to 1 if the land transaction occurred in year 2004, ε is the effort term.

Model regression results can be seen in the following table 7.1 and 7.2. The overall adjusted R^2 is 0.575, indicating that approximate 60% of the price variance can be explained by this basic model. Looking at the column for significance level in table 7.2, only the price of residential land is significantly higher than mixed land use. That is contrary to the fact that commercial lands are even more expensive than others, expect in fiscal year 2007, when the housing market was hit by the mortgage crisis. Also we see no apparent difference between transactions modes. Maybe that's because the amount of lands transacted through auction is relative small, unable to generate any significant results.

Fortunately, all other variables exhibited the expected outcomes. The natural logarithm of distance is negatively related to land value, proving that the Beijing subway system does have a positive impact on housing market. The FAR was also significantly and positively associated with the dependant variable. For the year dummy being tested, land prices since 2005 are all higher than those in year 2004. Although this dummy is able to control for the influence of fiscal year, it does not tell whether the difference is coming from real growth of property value or just the effect of inflation.

Table6. 1: Model Summary

R	R Square	Adjusted R Square	Standard Error of the Estimate
0.768	0.789	0.575	0.6673

Table6. 2: Coefficients Table

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	8.990	.349		25.758	.000
LndistoS	-.184	.042	-.147	-4.383	.000
FAR	.290	.018	.641	16.485	.000
L_Commercial	.168	.112	.073	1.497	.135
L_Residential	.180	.098	.087	1.850	.065
L_Others	.082	.128	.027	.642	.521
T_Listings	.036	.080	.017	.452	.652
T_Auction	-.289	.680	-.014	-.424	.672
Y2005	.152	.188	.039	.807	.420
Y2006	.319	.174	.098	1.826	.069
Y2007	.619	.174	.201	3.557	.000
Y2008	.554	.171	.178	3.228	.001
Y2009	.867	.166	.305	5.212	.000
Y2010	1.161	.164	.445	7.076	.000
Y2011	.858	.168	.315	5.104	.000

6.2. Adding District Dummy

Instead of examining only one or two subway lines covering a limited area, our research tries to study all stations within the city jurisdiction. As we have mentioned before, factors associated with specific political

districts also contribute to the price variance. Accordingly, we conducted a second analysis controlling for the influence of socio-economic characteristics of different districts.

A second regression model is described as below:

$$Ln(price) = \alpha + b_1 Ln(distoS) + b_2 FAR + L_i + M_t + Y_j + D_d + \varepsilon \quad (2)$$

where D_d is a dummy variable that equals to 1 when a land parcel falls in Fangshan District.

According to the regression results being shown in the below, the overall adjusted R^2 increases from 0.575 to 0.707. The explanatory ability of the new model has been enhanced dramatically. The distance variable and the FAR variable remain significant. Then turn to the new introduced district dummy. The significant column of table 7.4 shows that district Dongcheng, Xicheng, Chaoyang, Haidian, Chongwen, and Xuanwu all have higher average land price than Fangshan districts. This results meet our expectations, because Fangshan district is more of a suburban area, districts located in central urban area are supposed to have a more prosperous land market.

Table6. 3: Model Summary

R	R Square	Adjusted R Square	Standard Error of the Estimate
0.852	0.726	0.707	0.5536

Table6. 4: Coefficient Table

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	8.054	.309		26.051	.000
LndistoS	-.137	.037	-.110	-3.667	.000
FAR	.239	.016	.528	15.342	.000
L_Commercial	-.020	.097	-.009	-.208	.836
L_Residential	.108	.082	.053	1.329	.185
L_Others	-.032	.109	-.011	-.297	.767
T_Listings	.061	.073	.028	.835	.404
T_Auction	-.097	.571	-.005	-.170	.865
Y2005	.152	.159	.039	.952	.342

Y2006	.351	.148	.108	2.377	.018
Y2007	.592	.148	.192	4.012	.000
Y2008	.682	.145	.220	4.706	.000
Y2009	1.021	.140	.359	7.305	.000
Y2010	1.480	.141	.567	10.509	.000
Y2011	1.195	.150	.439	7.984	.000
D_Changping	.284	.124	.087	2.293	.022
D_Chaoyang	1.085	.115	.425	9.423	.000
D_Chongwen	1.432	.252	.168	5.692	.000
D_Daxing	.230	.126	.066	1.830	.068
D_Dongcheng	1.460	.227	.197	6.419	.000
D_Fengtai	.968	.115	.345	8.436	.000
D_Haidian	.971	.127	.278	7.614	.000
D_Shijingshan	.650	.166	.136	3.914	.000
D_Shunyi	.176	.158	.037	1.117	.265
D_Tongzhou	.494	.140	.131	3.538	.000
D_Xicheng	1.513	.250	.177	6.059	.000
D_Xuanwu	1.077	.235	.136	4.581	.000

6.3. Adjusting Distance Variables

9 out of all the 15 subways lines opened after 2008, when the Olympic Game was held. A certain amount of transactions happened before these lines were put into service. Studies has shown that the announcement and planning of rail stations also have a saying in determining location choice and the final price. However, since no solid information supports when a rail station start to exert influence, we assume that only existing stations would be taken into account when developers competing for a land. For this reason, distance variables in the previous models are underrated. To fix the problem, we associate each transaction record with the existing subway system based on the effective open time of stations. For instance, if a transaction is made in 2005, its nearest station must be among those already opened prior to 2005. After the distance adjustment, we got a new model as:

$$Ln(price) = \alpha + b_1 Ln(distoS_2) + b_2 FAR + L_i + M_t + Y_j + D_d + \varepsilon \quad (3)$$

where $distoS_2$ is the adjusted distance from each transaction to a nearest subway station.

As is seen in table 6.5 and table 6.6, the adjustment increases the R Square from 0.707 to 0.711, without undermining the significance level of other parameters.

Table6. 5: Model Summary

R	R Square	Adjusted R Square	Standard Error of the Estimate
0.854	0.730	0.711	0.54960

Table6. 6: Coefficient Table

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	8.274	.315		26.248	.000
$LndistoS_2$	-.128	.029	-.151	-4.390	.000
FAR	.245	.015	.541	15.965	.000
L_Commercial	-.025	.096	-.011	-.260	.795
L_Residential	.103	.081	.050	1.270	.205
L_Others	-.032	.108	-.010	-.293	.770
T_Listings	.056	.072	.026	.775	.439
T_Auction	-.230	.566	-.011	-.407	.684
Y2005	.219	.158	.056	1.384	.167
Y2006	.411	.148	.126	2.781	.006
Y2007	.614	.147	.199	4.188	.000
Y2008	.700	.144	.225	4.861	.000
Y2009	1.036	.139	.364	7.460	.000
Y2010	1.453	.140	.556	10.398	.000
Y2011	1.095	.150	.402	7.324	.000
D_Changping	.083	.125	.025	.659	.510
D_Chaoyang	.814	.124	.319	6.552	.000
D_Chongwen	1.234	.258	.145	4.781	.000
D_Daxing	.094	.125	.027	.753	.452
D_Dongcheng	1.136	.240	.153	4.745	.000
D_Fengtai	.816	.115	.291	7.087	.000
D_Haidian	.713	.139	.204	5.131	.000
D_Shijingshan	.338	.177	.071	1.905	.057
D_Shunyi	.051	.154	.011	.328	.743
D_Tongzhou	.262	.137	.070	1.914	.056
D_Xicheng	1.202	.261	.141	4.603	.000
D_Xuanwu	.813	.241	.103	3.380	.001

6.4. Grouping Stations

What are the relative roles of business center in determining adjacent land value? In other words, how much variance should be attributed to whether the land is in prosperous area or not? In section 6.2, district variables were introduced for controlling different socio-economic characteristics. But not matter how the local governments draw their political boundary, the emergence and the spillover effect of urban business centers can never be easily confined. Using district dummy can be arbitrary in this sense.

In this section, a new dummy variable is incorporated for internalizing these factors into stations. We classified all the station into four categories:

Table6. 7: Different Types of Station

Station Type	Description
C_01	Transfer Stop
C_02	Stations that are located within business district but are not transfer stop.
C_03	Stations that are located within inner city but belong to neither the first nor the second type.
C_04	All the other stations

A new model is shown as:

$$Ln(price) = \alpha + b_1 Ln(distoS_2) + b_2 FAR + L_i + M_t + Y_j + C_c + \varepsilon \quad (4)$$

where C_c is a dummy for stations types.

Here we use the fourth kind as bench mark to see how different kinds of stations affect land property value. Regression result is displayed in table 6.8 and 6.9. Because the total number of variable is much less than the previous one, the overall R square decreases. But still, it is much higher than the basic model. At the last three rows of table 6.9, it is shown that stations within commercial center and inner city play a more positive role in

promoting land values than those located in suburban area. It is interesting that the coefficient of C_01 is lower than the coefficient of C_02. Our interpretation is that transfer stops bear much larger ridership and the negative effects, such as high crime rate, noise issues, dominate. The coefficient of C_03 is the highest of three. But since only three transactions records fall within this group, more research is needed.

In summary, model of this section supports the argument that subway stations within inner city and business districts are more attractive to both transit customers and real estate developers.

Table6. 8: Model Summary

R	R Square	Adjusted R Square	Standard Error of the Estimate
0.832	0.692	0.679	0.5800

Table6. 9: Coefficient Table

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	9.166	.247		37.045	.000
$LndistoS_2$	-.217	.025	-.257	-8.546	.000
FAR	.255	.016	.561	16.068	.000
L_Commercial	-.011	.099	-.005	-.109	.914
L_Residential	.107	.085	.052	1.254	.211
L_Others	-.012	.112	-.004	-.109	.914
T_Listings	.051	.071	.023	.722	.471
T_Auction	-.230	.590	-.011	-.390	.697
Y2005	.356	.164	.092	2.171	.031
Y2006	.505	.153	.156	3.300	.001
Y2007	.753	.152	.244	4.947	.000
Y2008	.721	.150	.232	4.790	.000
Y2009	1.008	.146	.355	6.921	.000
Y2010	1.413	.145	.541	9.758	.000
Y2011	1.052	.147	.386	7.136	.000
C_01	.403	.068	.181	5.942	.000
C_02	.603	.083	.230	7.241	.000
C_03	1.085	.344	.090	3.153	.002

7. Conclusion

Using data on land transaction data in the City of Beijing, we examined whether proximity to a subway stations plays an important role in promoting land market. We found that they did. For all land use types except industrial land, the final unit prices are negatively related to their distance from a nearest subway stations. Because land prices are also determined by many other factors, such the intensity of land use, the effect of central business districts, the difference of commuting needs between urban and suburban areas, etc, we developed different models to control for these factors. Our results suggest that whether located near an urban business center is likely to alter the strategies of developers. Stations falling inside business districts would attract more ridership and encourage developers to appreciate lands property in close proximity. However, all transfer stops have less influence than those within commercial center, probably because of an excess volume of passenger flow that produces much more negative effect. In general, these results suggest that subway system is indeed a promoter for land market in the City of Beijing.

8. Reference

Boarnet, M. G. (2007). *Conducting Impact Evaluation in Urban Transport*. *Sustainable Development*. Retrieved from http://siteresources.worldbank.org/INTISPMA/Resources/383704-1146752240884/Doing_ie_series_05.pdf

Bowes, D. R., & Ihlanfeldt, K. R. (2001). Identifying the Impacts of Rail Transit Stations on Residential Property Values. *Journal of Urban Economics*, *50*(1), 1-25. doi:10.1006/juec.2001.2214

Case, K. E., & Mayer, C. J. (1996). Housing Price Dynamics Within a Metro- politan Area. *Regional Science and Urban Economics*, *26*, 387-407.

Debrezion, G., Pels, E., & Rietveld, P. (2006). The impact of rail transport on real estate prices: an empirical analysis of the Dutch housing market. *Tinbergen Institute Discussion Paper No. TI 06-031/3*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=895270

Fergusan, Bruce G., Mark A. Goldberg, and J. Mark. 1988.Thepre- service impacts of the Vancouver Advanced Light Rail Transit System on single family property values. In Real estate market analysis: Methods and applications, edited by J. M. Clapp and S. D. Messner. New York: Praeger.

Huang, H. (1996). The Land-Use Impacts of Urban Rail Transit Systems. *Journal of Planning Literature*, *11*(1), 17-30. doi:10.1177/088541229601100103

Litman, T. (2011). *Land Use Impacts on Transport: How Land Use Factors Affect Travel Behavior*. *Criticism*. Retrieved from http://www.vtpi.org/landtravel.pdf

Loukaitou-sideris, A. (2002). The geography of transit crime: Documentation and Evaluation of Crime Incidence on and around the Green Line Stations in Los Angeles. *Planning Education and Research*, 135-151.

McMillen, D. P., & McDonald, J. (2004). Reaction of House Prices to a New Rapid Transit Line: Chicago's Midway Line, 1983-1999. *Real Estate Economics*, *32*(3), 463-486. doi:10.1111/j.1080-8620.2004.00099.x

Munoz-Raskin, R. (2010). Walking accessibility to bus rapid transit: Does it affect property values? The case of Bogotá, Colombia. *Transport Policy*, *17*(2), 72-84. Elsevier. doi:10.1016/j.tranpol.2009.11.002

Rosen, S., Journal, T., & Feb, N. J. (1974). Hedonic Prices and Implicit Markets : Product Differentiation in Pure Competition. *Journal of Political Economy*, *82*(1), 34-55.

Serebrisky, T., Gómez-Lobo, A., Estupiñán, N., & Muñoz-Raskin, R. (2009). Affordability and Subsidies in Public Urban Transport: What Do We Mean, What Can Be Done? *Transport Reviews*, *29*(6), 715-739. doi:10.1080/01441640902786415

Smith, N. (1982). Gentrification and Uneven Development. *Economic Geography*, *58*, 139-155.