

1 **CAPITALIZATION EFFECTS OF RAIL TRANSIT AND BRT ON RESIDENTIAL**  
2 **PROPERTY VALUES IN A BOOMING ECONOMY: EVIDENCE FROM BEIJING**

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13 **ABSTRACT**  
14

15 This research investigates the capitalization effects of proximity to rail transit and BRT in fast-  
16 growing Beijing. Few related studies have been conducted for Chinese cities because the real  
17 estate market was not established until recently. Data were collected on apartment homes sold in  
18 the Beijing metropolitan area during 2011, and hedonic price modeling was employed to gauge  
19 the price premiums or discounts associated with proximity to transit stations. Overall, we  
20 identified an average price premium of around 5% for properties near rail transit stations, but no  
21 statistically significant effects are detected at BRT station areas. Moreover, we found that  
22 station-proximity effects increase both in magnitude and spatial extent at stations further away  
23 from the city center and at stations surrounded by low- and middle-income neighborhoods; for  
24 example, the price premium is as high as 10% in some suburban and low-income station areas.  
25 We concluded that rail-transit investment is an effective strategy for Beijing to reshape its urban  
26 spatial structure, and local governments in China may consider Rail + Property Development  
27 model as a future financing solution for rail-transit investment. This study contributes to the  
28 evidence of capitalization effects of public transit from a booming and transitional economy.  
29

## 1 INTRODUCTION

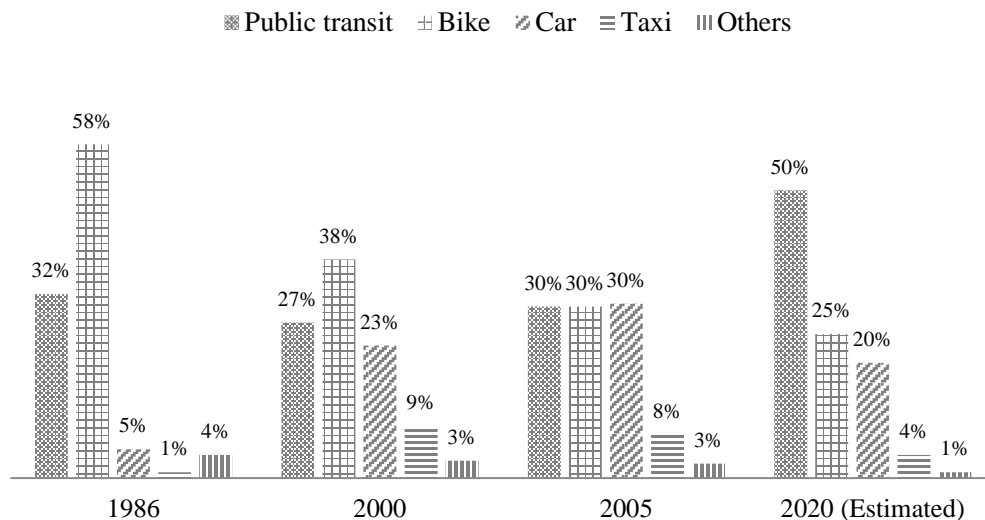
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3 Few studies have investigated the capitalization effects of transit investment on land and  
4 property values in Chinese cities. One reason for this is the social transformation during the past  
5 30 years that has occurred moving China from a socialist planning to a market-oriented system.  
6 Factor markets such as the housing and land market were not developed until recently before the  
7 1980s. Housing was a part of the social welfare system that was provided by the government in  
8 China. During the 1980s, a series of political and economic reform programs initiated by central  
9 government, result in the housing system being privatized and commercialized. In 1998, the  
10 public housing provision system was officially ended by central government, and from this point  
11 forward, individuals could only obtain homes by purchasing from the real estate market except a  
12 few working for government and state-owned corporations. During the past 10 years, housing  
13 market has boomed in most of metropolitan cities of China, this is partly due to the rapid  
14 urbanization process, and partly because of the enthusiasm of the local governments in land  
15 development. The maturity of the real estate market in recent years enabled us to explore the  
16 quantitative relationship between public-transport investment and property development within  
17 China, and China's growing and transitional economy provides a unique context for comparing  
18 and contrasting western countries and further investigating this relationship.

19 In contrast with most North American cities featuring stable urban patterns and a small  
20 percentage of public transit users, Chinese cities are developing differently. Fast urbanization  
21 and dramatic transformation are characteristics of Chinese cities today. For example in Beijing,  
22 the population has doubled from 9 million in 1980 to 19.6 million in 2010, and the built-up urban  
23 area has increased six-fold, from 184 square kilometers in 1980 to 1,209 square kilometers in  
24 2007 (Beijing Statistical Yearbook, 2011). In Beijing, the quantity of newly completed

1 residential construction reached 28.4 million square meters in year 2005, accounting for 13.1%  
 2 of existing housing market stock (Zheng and Kahn, 2008).

3 Dramatic expansion of urban space has changed individual travel behavior significantly  
 4 (FIGURE 1). The traditional modes of transportation, cycling and walking, are gradually  
 5 becoming impossible due to longer distances between work and home, while private cars are still  
 6 not affordable for most of the residents. Public transit, therefore, plays an ever more important  
 7 role for people's daily activities, and has become one of the predominant modes of transport in  
 8 many big cities of China. For example, the public transit mode share in Beijing was around 40%  
 9 in 2010, a 10% increase from the transit mode share of 2005, and this share is expected to go up  
 10 to 50% by 2020 due to substantial investment in the rapid transit system. Similarly, many other  
 11 cities in China, like Guangzhou, Chongqing, Xi-an, Chengdu, etc., are proposing new rail transit  
 12 or bus rapid transit (BRT) lines. This study aims to provide practical policy implications for  
 13 future transit investments in China by investigating the relationship between public-transit  
 14 investments and property development in Beijing.



15

16

**FIGURE 1 Changes of Travel Mode Choice from 1986-2020 of Beijing.**

17

Sources: Beijing travel survey (2007) and Beijing City Planning (2004-2020)

1 In particular, this study aims to test the following three hypotheses:

2 1. Rapid transit investment in Beijing confers benefits to residents lived close to transit  
3 stations, and the benefits of good accessibility get capitalized into the market value of  
4 properties.

5 2. Effect of proximity to rapid transit varies across station locations. In particular, the  
6 effects are lower at stations near the city center and greater at stations further away.  
7 Transit users lived in suburbs have longer commuting times, and therefore save greater  
8 travel time from rapid transit system than those lived close to the city center. Moreover,  
9 availability of other traffic modes, such as regular bus and taxi, is very limited in suburbs.  
10 Therefore, suburban residents are probably willing to pay more for being close to a rapid  
11 transit station.

12 3. Effect of proximity to rapid transit also depends on the socio-demographics of  
13 neighborhoods around stations. In particular, the effects are lower at high-income stations  
14 and greater at low-income stations. Low-income residents are more reliant on public  
15 transit for their daily trips than high-income residents as most low-income residence  
16 cannot afford a private car and most of them live in a suburb.

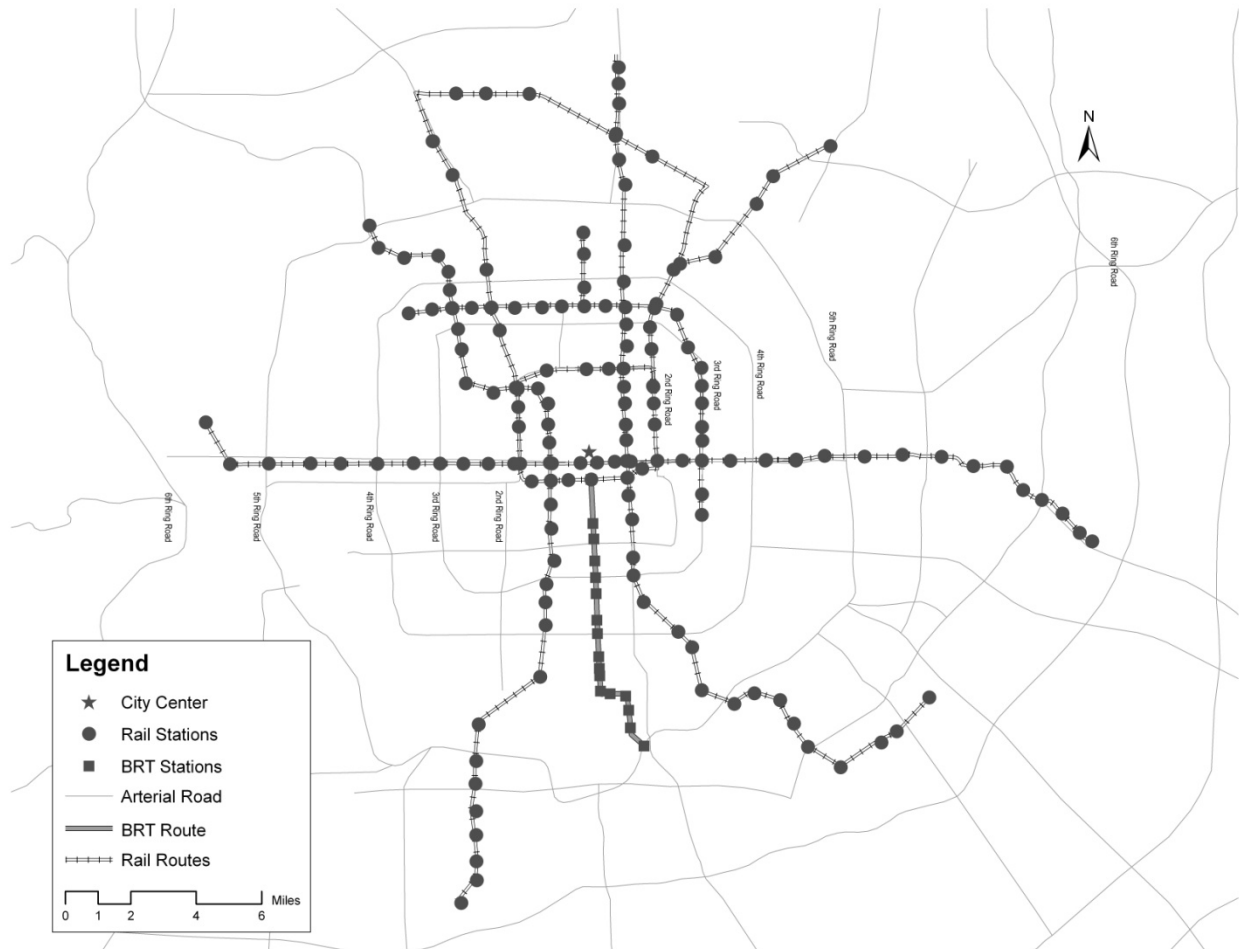
17 The built-up area within the sixth Ring road of Beijing is the focus of the study as most  
18 residents who work in downtown commute within this area. Therefore this area can be  
19 designated a complete land market. Within the study area, there were eleven rail transit lines, and  
20 one BRT line<sup>1</sup> operating in 2011. The location of these rail transit and BRT stations are shown in  
21 FIGURE 2.

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<sup>1</sup> There were two other bus lines also called BRT lines, however, they did not have dedicated right of way for the whole routes. The user benefits of these two lines were very limited, and therefore they were not included in this study.

1 In the next section we review the literature on the effect of public transit on land values or  
 2 rents in urban area. In section three we describe research methodology and data sources.  
 3 Following that, we present our model results, along with some insights and discussion from our  
 4 results, and we conclude in section five.

5



6

7

**FIGURE 2 Location of rail and BRT stations in Beijing as of 2011.**

8

## 1 **STUDIES OF TRANSIT AND PROPERTY VALUES**

2

3 The monocentric city model pioneered by Alonso (1964), Muth (1969), and Mills (1972)  
4 provides a theoretical framework for analyzing the interactions between transit investment and  
5 land use. The model suggests that urban activities are arranged according to the transportation  
6 cost: the closer to the city center, the lower the transportation cost. Firms and households make  
7 trade-offs between access to the city center (market) and property price. The choice of location  
8 for households and firms is determined by their willingness to pay for different sites in the city.  
9 If a place could offer better accessibility to the city center, consumers would be willing to pay a  
10 higher price to be located at that place. Therefore, it is hypothesized that if rapid transit brings  
11 time saving for travelers, there would be a price premium for living in proximity to a transit  
12 station. During the last several decades, abundant research has tested this hypothesis based on  
13 evidence worldwide.

### 14 **Impacts of Rail Transit on Property Values**

15

16 Empirical studies on the relationship between the rail transit and property values can be traced at  
17 least to the 1970s. A recent statistics of Duncan (2011) finds there are at least 50 studies on this  
18 topic.

19 The majorities of these studies collect cross-sectional data and employ hedonic price  
20 modeling to extract the sole effect of rail transit on property values. Conclusions of these studies  
21 are highly mixed, though majority found a price increase for residential properties near rail  
22 transit. Firstly, the magnitude of premiums varies significantly between studies due to different  
23 methodology and research context. Thus it is difficult to make a generalization, but a great deal  
24 of literature implies that, based on the evidence of North America, the range of price premiums

1 for single family properties should be between 0%-10% (Landis et al., 1995; Debrezion et al.,  
2 2007; Hess and Almeida, 2007; Duncan, 2011), and price premiums for multi-family properties  
3 are probably much larger, which can be two or three times higher than that for single-family  
4 housing (Cervero and Duncan, 2002a, 2002b; Duncan, 2008). Though the mixed results are  
5 attributed to the varied methodology, geography, and socio-economic context of research area,  
6 another important reason is the failure of these studies to control for factors such as local real  
7 estate market conditions, possible negative disamenities (e.g., crime and noise), and design  
8 features around station area, which may confound the relationship between accessibility of  
9 transit and property values (Bartholomew and Ewing, 2011).

10 In recent years, several studies with new data have supplemented the previous studies by  
11 identifying the factors intervening in the relationship between the rail transit proximity and  
12 property values. Bowes and Ihlanfeldt (2001) quantitatively explored the positive effects (e.g.,  
13 attracting retail activities) and negative effects (e.g., more crime near a station) of being close to  
14 rail stations, and concluded that both effects influenced the relationship between property values  
15 and rail station accessibility. They also found that larger proximity effects were associated with  
16 high-income neighborhoods and locations further from the Central Business District (CBD)  
17 center. Their finding of a large premium at stations further away from the CBD is expected  
18 because there is more time savings from rapid transit for longer commuters. Their finding on  
19 greater premiums at high-income neighborhoods, however, is contrary with expectation.  
20 Generally, low-income residents are more reliant on public transit for daily travel and thus they  
21 may be more inclined to pay more for living near transit stations. They explained this contrary  
22 result was related to the higher opportunity cost of commuting time for high-income residents.  
23 Similar with findings of Bowes and Ihlanfeldt (2001), Hess and Almeida (2007) also found that

1 rail transit proximity effects were positive within high-income station areas but negative in low-  
2 income station areas, and they contended the reason for the counterintuitive result was because  
3 of the counter-traditional city pattern of Buffalo, New York, where old and low quality housing  
4 is located in the CBD and housing prices increase over distance to the CBD. An early study from  
5 Nelson (1992), however, found a positive effect of proximity to rail transit stations on properties  
6 within low-income neighborhoods and a negative effect on properties within high-income  
7 neighborhoods. He argued that accessibility benefits are larger than any nuisances from stations  
8 for low-income neighborhoods, while nuisances more than offset the benefits for high-income  
9 neighborhoods. For the connection between design feature and proximity effects, Duncan (2011)  
10 investigated the association between housing price premium and Transit-Oriented Development  
11 (TOD) design, and found that TOD design at stations' surrounding areas significantly enhanced  
12 the effects of rail transit on property values.

### 13 **Impacts of BRT on Property Values**

14

15 Compared with rail transit studies, studies linking BRT with land use are relatively new, but over  
16 the past 10 years, literature related to land use with BRT investment has increased. It is  
17 traditionally thought that bus transit services have little effect on urban form and land-use  
18 patterns due to the lower levels of services compared with rail transit and, thus, no bus proximity  
19 premiums are capitalized into the land values nearby (Cervero and Kang, 2009). Knight and  
20 Trygg (1977) examined HOV-bus lanes in Washington, DC, California, Seattle in Washington  
21 state, and Florida, they concluded that exclusive bus lanes incorporated into highways appeared  
22 to have no impact on either residential or commercial development. More recently, Cervero and  
23 Duncan (2002c) used hedonic price modeling to estimate the premium of access to BRT in Los



1 Angeles County. They found that there was no premium accrued to nearby multi-family parcels,  
2 rather negative impacts were detected.

3 On the contrary, more and more research finds significantly positive impacts of BRT on the  
4 values of the residential properties surrounding its stations. For example, Mullins et al. (1990)  
5 found that the BRT route in Ottawa, Canada had an effect on the development of land  
6 surrounding the stations to a certain extent. Levinson et al. (2002) contended that BRT in Ottawa,  
7 Pittsburgh, Brisbane, and Curitiba could have land-use benefits similar to those produced by  
8 rapid rail as long as the BRT and land-use planning for station areas could be integrated as early  
9 as possible. They stipulated that realizing the benefits of a BRT system required close  
10 coordination of land-use and transport planning from the beginning. In addition, Levinson et al.  
11 (2003) studied the BRT southeast line in Brisbane, Australia, and they found that the value of  
12 properties near the busway were 20% higher than those farther away and property values within  
13 6 miles of stations grew 2 to 3 times faster than those at a greater distance.

14 Furthermore, Bogota's BRT system is frequently cited as a case study. Rodriguez and Targa  
15 (2004) employed a hedonic price model to analyze the feasibility of BRT in Bogota and found  
16 out that for every 5 minutes of additional walking time to a BRT station, the rental price  
17 decreased by between 6.8% and 9.3%. Rodriguez and Mojica (2009) compared the asking prices  
18 of residential properties belonging to an BRT "intervention area" and a "control area" in Bogota  
19 and found 13%-14% higher prices in the BRT "intervention area" than in the "control area" after  
20 adjusting for structural, neighborhood, and regional accessibility characteristics of each property.

21 In the meantime, some scholars believe that the ability of BRT to impact land use depends on  
22 other non-accessibility factors. Polzin and Baltes (2002) argued that the extent to which BRT  
23 was able to create land-use impacts would significantly depend on the actions of professional

1 planners, funding agencies, and decision makers toward leveraging the investment in BRT. If the  
2 decision makers or professional planners delivered good information of locating close to BRT to  
3 developers, development would happen near the BRT station. Estupinan and Rodriguez (2008)  
4 found that the built environment attributes, like crosswalks and sidewalks, were important in  
5 explaining boarding rates for Bogota's BRT stations.

## 6 **Literature Gaps**

7

8 In summary, it has been well established in developed countries that rail transit investment  
9 promotes property development, however, the evidence from developing countries is very  
10 limited. The policy implications derived from previous studies based on western countries may  
11 not be applicable in developing countries due to different political and economic structure,  
12 different zoning system, and different socio-demographics of transit users. In addition, few  
13 previous studies have examined the how the station-proximity effects are influenced by other  
14 confounding factors, such as station location, socio-demographical characteristics of transit users,  
15 and urban design around station area. Answering this question will help to make more effective  
16 policies tailored to specific urban districts and groups of transit users. This study aims to partially  
17 fill in these gaps in the literature by investigating the case of Beijing.

18 Moreover, empirical studies on BRT are rather limited and results from current studies are  
19 highly mixed. Mixed results are associated with different BRT facilities and services, places, and  
20 characteristics of cities, such as the urban density, urban economic level, urban spatial structure,  
21 or the locations of the BRT line in the city, or people's travel culture in different places. This  
22 study aims to provide another unique context to examine the hypothesis linking BRT and land  
23 development.

# 1 METHODOLOGY AND DATA

## 2 Model Specification

3

4 To explore the effects of proximity to stations on property values, a standard hedonic price  
 5 model was used. As semi-log is a common form of such a model, we specified the dependent  
 6 variable as the natural log of sale price per square meter. It should be noted that the interpretation  
 7 of estimated coefficient should be the approximate percentage change of sale price associated  
 8 with one unit change of independent variable.

$$9 \quad \ln P = c + \sum a_3 X_s + \sum a_2 X_n + \sum a_1 X_l + \sum a_0 X_p + \varepsilon \quad (\text{Model 1})$$

10 In the equation, P is the sale price per square meter of the residential property;  $X_s$  indicates  
 11 structural characteristics of the property, such as size and design of the property,  $X_n$  indicates  
 12 neighborhood conditions for the property, such as services and amenities of the neighborhood,  $X_l$   
 13 indicates regional location of the property, and  $X_p$  indicates proximity to transit stations.  $a_3, a_2, a_1$   
 14 and  $a_0$  are coefficients to be estimated; c is the model constant, and  $\varepsilon$  is the residual error. This is  
 15 the basic model employed to estimate the effect of proximity to a station on property values.

16 In order to test Hypothesis 2 and 3, two additional models are built by creating interactive  
 17 terms based on the basic model. Model 2 aims to test whether the distance between station and  
 18 the city center influence the proximity effects. Model 3 aims to test whether the proximity effects  
 19 vary among neighborhoods with different income levels.

$$20 \quad \ln P = c + \sum a_3 X_s + \sum a_2 X_n + \sum a_1 X_l + \sum a_0 X_p + \sum b(X_p * Z_d) + \varepsilon \quad (\text{Model 2})$$

$$21 \quad \ln P = c + \sum a_3 X_s + \sum a_2 X_n + \sum a_1 X_l + \sum a_0 X_p + \sum b(X_p * Z_a) + \varepsilon \quad (\text{Model 3})$$

1 In the above two equations,  $X_p$  indicates the proximity to stations;  $Z_d$  indicates the property's  
2 distance to the city center;  $Z_a$  indicates the property's administration fee, which is used to  
3 represent the income level of the neighborhood;  $X_p * Z_d$  is the interactive term between  
4 proximity to stations and property's distance to city center; and  $X_p * Z_a$  is the interactive term  
5 between proximity to stations and property's administration fee. The administration fee of a  
6 neighborhood in China is a comprehensive index to reflect the whole quality of a neighborhood;  
7 a higher administration fees means higher levels of services and better amenities in the  
8 neighborhood. People with different income level are sensitive to this fee. Neighborhood  
9 services are unique for residents, and only high-income people are willing to pay higher  
10 administration fees to enjoy extra services and amenities. Therefore, it is reasonable to use  
11 administration fee to represent the income level of residents in each neighborhood.

## 12 **Data Sources**

13

14 The attributes and transaction data of each residential property are available from a primary  
15 housing transaction website ([www.soufun.com](http://www.soufun.com)), which is based in China. The site provided  
16 information on tremendous property transactions covering whole Beijing in 2011, and we only  
17 selected second-hand properties and those located within study area. This includes data on  
18 property prices per square meter, structural and locational information of property, and  
19 information on neighborhood amenities. Different from first-hand property transactions, which  
20 are mainly distributed in suburbs, second-hand transactions cover far more heterogeneous  
21 properties and a broader area from the inner city to the outskirts of the city. After deleting the  
22 missing data, 1,695 sampling properties are geocoded in GIS and selected for the final model  
23 estimation.

## 1 **Variable Specification**

2  
3 The natural logarithm of sale prices per square meter serves as the dependent variable in the  
4 model. Independent variables accounting for property characteristics can be divided into four  
5 kinds: structural variables, neighborhood variables, locational variables and proximity variables.

6 Ten variables are created to explain the structural characteristics of property, including  
7 number of bedrooms (*Bedroom*), living rooms (*Living room*), bathrooms (*Bathroom*), and  
8 kitchens (*Kitchen*), orientation of apartment (*Head*), whether it is a business apartment  
9 (*Business*), ventilation condition (*Ventilation*), low-rise (*FL6*) or high-rise building (*FL18+*), and  
10 age of the apartment (*Age*). Bedroom, living room, bathroom, kitchen, and age are the most  
11 commonly used variables in hedonic price model (Hess and Almeida, 2007; Duncan, 2011),  
12 while others are closely associated with the culture of China. Orientation of apartment (*Head*), in  
13 particular whether the home faces South, is a concern for Chinese in choosing their homes.  
14 South-faced houses have several advantages over houses faced to other directions, for example  
15 south-faced houses can block most of the sunlight in summer while allowing more sunlight shed  
16 into the room in winter. South-faced properties are therefore preferred by most home buyers in  
17 China. Business apartments, which are originally designed for the business persons for  
18 temporary living, have a higher standard of neighborhood services than common apartments, and  
19 most business apartments are already furnished (e.g., painted walls and flooring) by developers.  
20 People buying a business apartment prefer its high quality of services and convenience to move  
21 in. Ventilation condition, is defined as, whether or not the houses has windows on both north and  
22 south walls, and if so, it means good ventilation because the predominant wind direction of  
23 Beijing is north and south and thus houses structured with north and south windows can drive air  
24 flow within rooms. Moreover, we assumed that residents of Beijing are not willing to choose the

1 low-rise apartment building (6 stories or fewer), most of which were built before the 1980s and  
2 located in old neighborhoods, nor the super high-rise buildings (more than 18 stories), which  
3 means super high population density within neighborhoods.

4 Eight variables are selected to represent neighborhood characteristics. As mentioned above,  
5 administration fee (*Admin\_Fee*) represents the levels of service in the neighborhood, including  
6 security, sanitation, maintenance, and other management services. The ratio of green space  
7 (*GreenR*) in a neighborhood also represents quality of natural environment and density of the  
8 neighborhood, and a higher ratio of green space means a better neighborhood environment. Floor  
9 area ratio (*FAR*) reflects the building density of the neighborhood, and a lower FAR is associated  
10 with better amenities and a higher price. Similar to school enrollment systems in the U.S.,  
11 schools in Beijing are also run by school districts. Even though most residential neighborhoods  
12 have schools and kindergarten nearby in Beijing, schools and kindergartens of high quality and  
13 good reputation are rare resources. Most parents with children treat school district as their top  
14 priority in choosing their new homes, and thus good school districts should create a significant  
15 premium in housing price. We identified the top 50 kindergartens (*Kindergarten*), elementary  
16 (*Elementary*) and middle schools (*Middle*) based on their enrollment rate and reputation as the  
17 standard to designate the good school districts in Beijing, and property attributes data include  
18 school district information that enable us to identify whether the property belongs to one of the  
19 good school districts. Moreover, proximity to an open space can have significant effects on a  
20 home's sale price (Bolitzer and Netusil, 2000). In order to measure the effect of parks on housing  
21 price, the properties located within a walkable distance (1/4 mile) of major parks (*Parks*) in  
22 Beijing were identified. Finally, the percentage of commercial and entertainment land use (*Com*)  
23 around the property also can influence the property value (Song and Knaap, 2004).

1 Three variables measuring regional location of property are created. Distance to city center  
2 reflects (*Dis\_Center*) the regional location of properties in the city, and higher proximity to the  
3 city center means lower transportation costs. Tiananmen Square is the traditional center of  
4 Beijing, and people very care about their home's distance to this center even though its cultural  
5 meaning as a center is more than its significance as an actual employment center. Moreover,  
6 Beijing is gradually transforming from a typical mono-centric to a poly-centric urban pattern  
7 (Feng et al., 2009), and there are several sub-centers that have emerged, such as Zhong Guancun,  
8 CBD, Jin Rongjie, Yizhuang, Shangdi, etc., therefore we also calculated property's distance to  
9 these sub-centers (*Dis\_Emp*). Also, distance to the nearest arterial road (*Dis\_Road*) reflects the  
10 level of accessibility of residents.

11 For station proximity variables, we first created variables using different buffer widths (say,  
12 0.25, 0.5, 1, 1.25, 1.5, 2 mile<sup>2</sup>) and added all into the model, but we found that proximity  
13 distance over 1 mile was hardly significant in the model, and therefore we only kept the  
14 following four variables in the final models: apartments located within ½ mile of rail stations  
15 (*Rail\_Hlf*); apartments located between one-half and one mile of rail stations (*Rail\_Hlf\_One*);  
16 apartments located within one-quarter mile of BRT stations (*BRT\_Qtr*); and apartments located  
17 between one-quarter and one-half mile of rail stations (*BRT\_Qtr\_Hlf*).

18 The variable names and corresponding summary statistics are provided in TABLE 1.

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<sup>2</sup> Distance bands were calculated based on Euclidian distance rather than network distance due to the lack of data for detailed street network.

1

**TABLE 1 Variable Summary Statistics (N=1695)**

Variables	Description (Unit of Measure)	Mean	Std. Dev.
<b><i>Dependent Variables</i></b>			
Price	The sale price per sq. meter of floor area of the sold housing units (RMB/Sq. meter)	28,696	13,804
LnPrice	Natural log-transformation of the sale price	10.19	.39
<b><i>Structural Variables</i></b>			
Bedroom	# Bedrooms in the apt (#)	2.20	.87
Living room	# Living rooms in the apt (#)	1.32	.52
Bathroom	# bathrooms in the apt (#)	1.25	.53
Kitchen	# kitchens in the apt (#)	1.01	.16
Head	Direction of home entrance faces (Binary: 1=south)	.69	.46
Business	Business apartment: aim for business persons (Binary: 1=yes)	.03	.17
Ventilation	Both North and South walls have windows (Binary: 1=yes)	.68	.47
FL6	Building 6 or less stories high (Binary: 1=yes)	.43	.50
FL18+	Building 18 or more stories high (Binary: 1=yes)	.22	.41
Age	Age of the building (#)	11.78	6.72
<b><i>Neighborhood Variables</i></b>			
Admin_Fee	Fees for neighborhood admin and services (RMB/Sq. meter/month)	1.98	1.93
GreenR	Ratio of open space within neighborhood (percentage)	26.80	13.89
FAR	Floor area ratio	2.67	1.58
Middle	Have top-ranked middle school (Binary: 1=yes)	.34	.47
Elementary	Have top-ranked elementary school (Binary: 1=yes)	.28	.45
Kindergarten	Have top-ranked kindergarten (Binary: 1=yes)	.29	.45
Parks	Have parks within quarter mile of property (Binary: 1=yes)	.08	.27
COM	Ratio of commercial and entertainment land use within quarter mile of property (percentage)	13.77	12.24
<b><i>Locational Variables</i></b>			
Dis_Center	Property distance to the city center (mile)	5.77	3.47
Dis_Emp	Property distance to the nearest sub-centers (mile)	3.42	2.30
Dis_Road	Property distance to the nearest arterial road (feet)	426.5	328.1
<b><i>Proximity Variables</i></b>			
Rail_Hlf	Property located within in a half-mile of rail station (Binary: 1=yes)	.34	.48
Rail_Hlf_One	Property located between a half and one mile of rail station (Binary: 1=yes)	.32	.47
BRT_Qtr	Property located within a quarter-mile of BRT station (Binary: 1=yes)	.03	.17
BRT_Qtr_Hlf	Property located between a quarter and a half mile of BRT station (Binary: 1=yes)	.08	.27

2

Note: 1RMB= 0.156 US Dollar (based on average exchange rate of 2011).



## 1 **RESULTS AND DISCUSSION**

2  
3 TABLE 2 presents the coefficients, standard errors and significance statistics for the three  
4 models. The three models all have a good overall fit with an  $R^2$  above 0.6. Most of the  
5 controlling variables show statistically significant coefficients with the expected sign. Variance  
6 inflation factors (VIF) for all variables are all below 3, indicating that no serious  
7 multicollinearity problems exist in the models. We also considered the potential endogeneity  
8 problem; however, an advantage of conducting such a study for Beijing is the location of many  
9 public goods (e.g., key schools and parks) is exogenous to housing price due to the former  
10 planning economy and path dependency (Zheng and Kahn, 2008). Many of the core public goods  
11 in Chinese cities were planned and built long ago by central or local governments and seldom  
12 change their locations after they are built. The last issue associated with using hedonic price  
13 modeling is the potential spatial dependence effect, which is supposed to bias the estimation of  
14 OLS. A spatial error model with spatial weighting matrices is often employed to correct this  
15 problem. Empirical studies comparing estimates from OLS and spatial error models, however,  
16 suggest that there is no significant difference between them (Mueller and Loomis, 2008), and  
17 OLS estimates are still unbiased in the presence of spatial error dependence and spatial  
18 heteroskedasticity (Anselin, 1988).

### 19 **Structural Characteristics**

20  
21 Results of Model 1 indicate that, all else being equal, one more living room and bathroom are  
22 associated with a 3.7% and 9.8% increase in property price; the south-faced design of houses  
23 raises property price by 4.4%; the price of business apartments is approximately 9.0% higher

1 than the average apartment price; good ventilation design adds 5.5% additional value to the  
2 house; and low-rise or super high-rise buildings are not welcomed by homebuyers in Beijing.

### 3 **Neighborhood Characteristics**

4

5 Moreover, all else being equal, one RMB increase of neighborhood administration fee is  
6 associated with a 2.8% increase of property price, indicating home buyers' concern for the  
7 quality of neighborhood services; a higher ratio of green space within neighborhood and being  
8 close to a park are positively and significantly associated with property price, indicating residents  
9 of Beijing pay much attention to the natural environment within and around their neighborhoods;  
10 being located within the districts of top middle schools, top elementary schools, and top  
11 kindergartens elevates the property price by 2.5%, 5.6%, and 3.0% respectively; and the ratio of  
12 commercial and entertainment land use around neighborhood is also significantly related to  
13 property price: the higher the ratio, the higher the property price.

### 14 **Locational Characteristics**

15

16 One kilometer distance from the city center and sub-centers is associated with a 3.5% and 2.5%  
17 decrease of property price. This result reconfirms the argument that Beijing is emerging in a  
18 polycentric urban pattern. Distance to the nearest arterial road is not significant, and this is  
19 probably due to the counteracting effects of being close to highway: accessibility and  
20 disamenities (e.g., noise and gas emissions).

### 21 **Transit Proximity Effects**

22

23 For proximity variables, we find interesting results from the three models. Results of Model 1  
24 detect statistically significant price premiums for properties within a half mile of station area; in

1 particular, locating within a half mile of rail transit stations brings a 4.8% increase on property  
2 price. The magnitude of this proximity effect in Beijing is at the same level as the effects found  
3 in U.S. cities. Beyond the half-mile radius area, however, effects of proximity to rail transit are  
4 not statistically significant any more.

5 Moreover, no statistically significant proximity effects are detected within a quarter mile of  
6 BRT stations, even significantly negative effects are found between one-quarter and one-half  
7 mile of BRT stations. The negative sign of coefficient may contribute to the factors that are not  
8 controlled in the model, but these results at least indicate that capitalization effect of this BRT  
9 line upon property value is negligible.

10 Differences on attributes between BRT and rail transit, such as capacity, guide way,  
11 frequency, comfort, punctuality, etc., contribute to the smaller effects of BRT than rail transit.  
12 This BRT line has a dedicated right-of-way and the average operating speed can reach 16 miles  
13 per hour, which is lower than average speed of rail transit lines in Beijing, 21-31 miles per hour.  
14 In addition, though it operates at the same headway (2 minutes) as rail transit lines during the  
15 peak time, its daily average ridership (150,000 person times) is less than a quarter of average  
16 daily ridership of rail transit lines (750,000-1,000,000 person times).

17 Another reason for non-significant effects of proximity to BRT stations may contribute to the  
18 design features of the station's nearby area. It was very difficult for the residents nearby to  
19 access to the BRT stations; BRT riders had to either use a pedestrian bridge or walk through an  
20 underground corridor to reach the stations. As Estupinan and Rodriguez (2008) found, the built  
21 environment attributes around station, like crosswalks and sidewalks, were important for BRT to  
22 have premium effects. Absence of walkable environments in the immediate area of BRT stations,  
23 therefore, is probably another factor that limits the effects of this BRT line. In addition, the lack

1 of integration of the BRT station design and zoning around the station area in advance is possibly  
2 another important factor contributing to the insignificant effects of this BRT line. Levinson et al.  
3 (2002) suggested that early integration of station design and zoning is one of the prerequisites for  
4 BRT having similar effects as rail transit on property values.

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1 \*, \*\* and \*\*\* denote statistical significant at 90%, 95%, and 99% level of confidence (two-tailed test), respectively.

## 2 **Relationship between Proximity Effects and Distance to City Center**

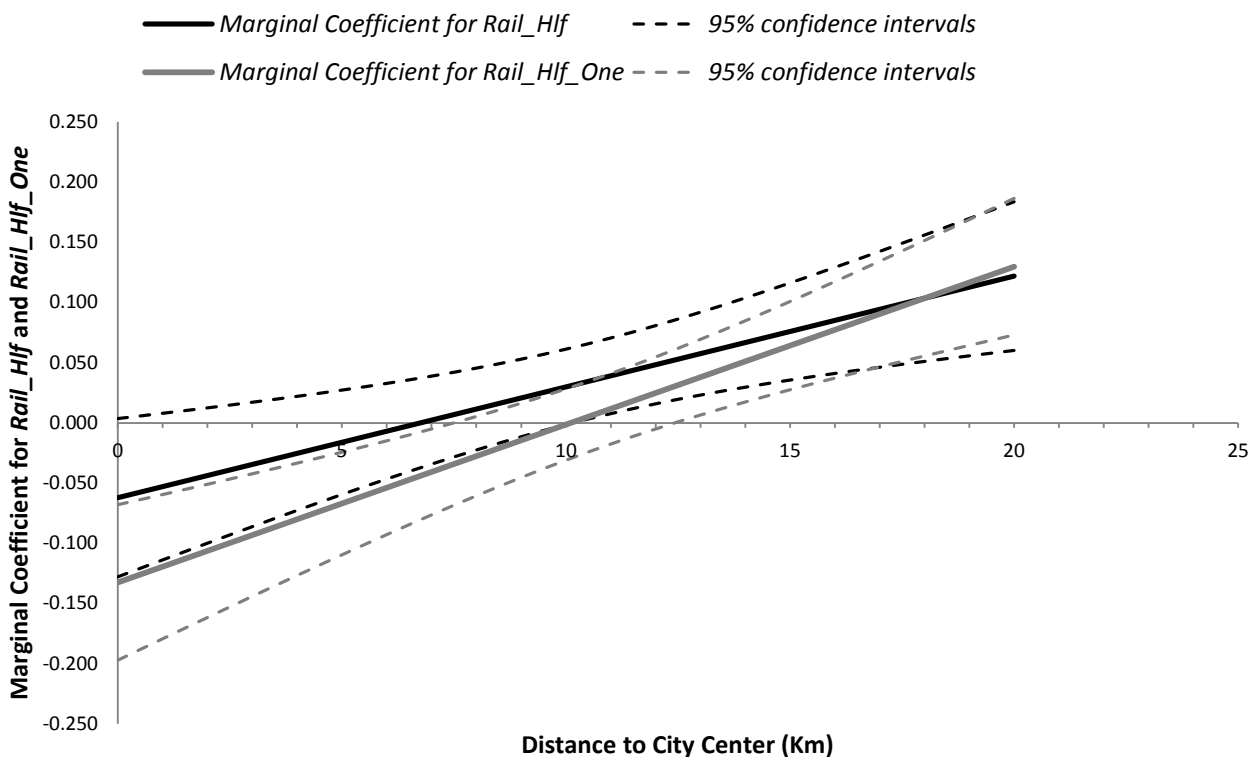
3  
4 The results of Model 2 show the interactions between station proximity and the property's  
5 distance to the city center are positive and statistically significant for three of the four interaction  
6 terms, indicating that premiums of access to transit stations increase as distance from the city  
7 center increases. In other words, the further a station is from the city center, the larger the effect  
8 of the proximity to the station. This result is expected because more commuting time can be  
9 saved from rapid transit for residents living further away from downtown, and aligns well with  
10 the findings from Bowes and Ihlanfeldt (2001).

11 Moreover, we calculate the marginal coefficient for station proximity as moderated by  
12 distance to the city center. Only the results of rail transit are shown in FIGURE 3, because the  
13 marginal effect of BRT is not significant at any distance. The equations developed by Aiken and  
14 West (1991) are used for calculating the marginal coefficient and corresponding standard error.  
15 The calculated marginal coefficient and corresponding 95% confidence intervals are then plotted  
16 in FIGURE 3, where the solid line indicates the marginal coefficient, and the dashed lines  
17 indicate the 95% confidence interval for the coefficient. If the 95% confidence interval crosses  
18 zero, then the  $P$  value must be greater than 0.05. Conversely, if the 95% confidence interval does  
19 not cross zero, then the  $P$  value must be less than 0.05.

20 FIGURE 3 shows the size and 95% confidence interval of the marginal coefficient for *rail\_hlf*  
21 and *rail-hlf-one* as moderated by *dis\_center*. It clearly illustrates that proximity effect goes up as  
22 distance to the city center increases. For half-mile proximity area (*rail\_hlf*), only the stations  
23 more than 6.2 miles (10 kilometers) away from the city center confer statistically significant  
24 effects on apartment price, and for half- to one- mile proximity area (*rail\_hlf\_one*), statistically

1 significant price premiums are only detected at stations more than 8.1 miles (13 kilometers) from  
2 the city center. We should note that coefficient for *rail\_hlf\_one* was not significant in Model 1  
3 but become significant at suburban stations, and this indicates that the spatial extent of the  
4 proximity effect also increases at stations farther from the city center. Moreover, stations located  
5 at approximately 12.42 miles (20 kilometers) away from the city center can contribute as high as  
6 12% premiums on property price.

7



1  
2 **FIGURE 3 Marginal coefficient for *Rail\_hlf* and *Rail\_hlf\_one* as conditioned by distance to**  
3 **city center.**

#### 4 **Relationship between Proximity Effects and Income Level of Residents**

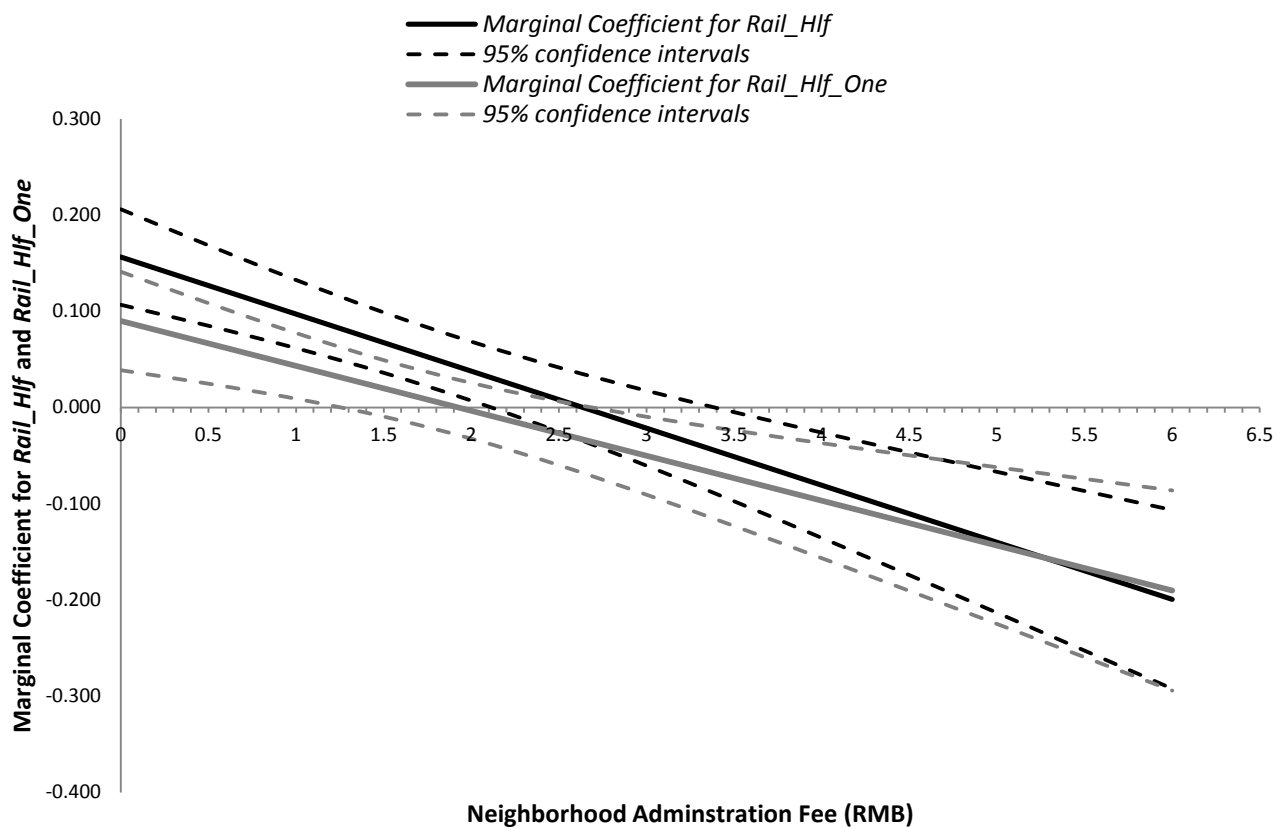
5  
6 The results of Model 3 show the interactions between station proximity and administration fee of  
7 neighborhood are negative and statistically significant for three of the four interaction terms,  
8 indicating that homeowners in high-end neighborhoods are reluctant to pay for being close to a  
9 transit station. In other words, the effects of station proximity are greater in stations surrounded  
10 by low- and medium- income neighborhoods. This result is consistent with the findings from  
11 Nelson (1992), but contrary to Bowes and Ihlanfeldt (2001) and Hess and Almeida (2007).  
12 Marginal coefficient for station proximity as moderated by administration fee was also calculated  
13 for both rail transit and BRT, but still the marginal effect of BRT was not significant at any level  
14 of administration fee. We therefore only reported the results of rail transit.



1       FIGURE 4 shows the size and 95% confidence interval of the marginal coefficient for *rail\_hlf*  
2     *and rail\_hlf\_one* as moderated by *Admin\_Fee*. FIGURE 4 clearly illustrates that proximity effect  
3     goes down as administration fee increases. For the half-mile proximity area (*rail\_hlf*), significant  
4     price premiums are only detected for neighborhoods with an administration fee of less than 2  
5     RMB, which generally applies to most low- to medium- income neighborhoods in Beijing.  
6     Statistically significant price discounts, however, are found at stations in neighborhoods with an  
7     administration fee of higher than 3.5 RMB, which generally applies to the high-income  
8     neighborhoods in Beijing. Similarly, for the half- to one- mile proximity area (*rail\_half\_one*),  
9     significant price premiums are found for neighborhoods with an administration fee of less than  
10    1.5 RMB, with significant price discounts for neighborhoods with an administration fee of more  
11    than 3.0 RMB.

12       These results suggests that, in Beijing, low- and medium- income residents are more  
13    dependent on public transit because they cannot afford a car, and the benefits of access transit  
14    stations more than offset any nuisances generated by stations for low- and medium- income  
15    neighborhoods, while nuisances more than offset the benefits for high-income neighborhoods.

16



1

2 **FIGURE 4 Marginal coefficient for *Rail\_Hlf* and *Rail\_Hlf\_One* as conditioned by**  
 3 **administration fee.**

4

## 1 CONCLUSION AND POLICY IMPLICATIONS

2  
3 Overall, with the evidence from Beijing, we can draw the conclusion that there are statistically  
4 significant price premiums for accessing rail transit stations, but no statistically significant  
5 effects for being close to BRT stations. Results from models with interaction terms further point  
6 out that station proximity effects can be greater both in size and spatial extent at locations further  
7 from the city center and in low-income neighborhoods.

8 Rapid transit development is an important strategy for Beijing to reshape its urban spatial  
9 structure and change people's travel behavior. This study shows that rail transit attracts property  
10 development and encourages high-density development nearby station areas. Therefore urban  
11 planners or policy makers in Beijing may use rail-transit investment as an effective tool to guide  
12 development of urban spatial patterns and to promote urban regeneration in some old and poor  
13 districts. On the other hand, urban planners in Beijing may increase the allowed development  
14 density nearby station areas by zoning to enable the land-development impact of rail transit to  
15 happen, especially to the station proximity areas in the suburbs. Significant capitalization effect  
16 of rail transit implies the possibility of other creative financing strategies, such as "Rail +  
17 Property Development" (R+P) model (Cervero and Murakami, 2008), which has been  
18 successfully operated in Hong Kong for many years. Under the R+P model, Hong Kong is one of  
19 the few places in the world where public transit makes a profit. Facing the tremendous debt in  
20 rail investments, local governments in China may consider the R+P model as a future financing  
21 solution.

22 This study also indicates that the priority to locate rail-transit stations should be in the low-  
23 and medium- income neighborhoods, whose residents are more dependent on public transit for  
24 daily travel activities, and in the meantime, planners should take actions to mitigate the negative

1 externalities emitted by the stations, especially the negative effects for the high-income  
2 neighborhoods.

3 For BRT, this study indicates that BRT does not confer statistically significant effects on  
4 residential land development even though it brings accessibility benefits to nearby residents.  
5 Improvement on the level of service and planning interventions that integrate station design and  
6 residential land development in advance may strengthen the effects of future BRT investments  
7 on land development.

8 Finally, it requires mention that cross-sectional nature of this study limits its causal inference,  
9 and a before-after study design can make more rigorous evaluation of the effect of transit  
10 investment on land development.

11

12

### 13 **ACKNOWLEDGEMENTS**

14

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16 Land Policy.

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