

Urban Land Value with Site Density Restriction: An Empirical Study of Beijing, China

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ABSTRACT

With an ideology of setting up a socialist market economy with China's characteristics, land as one of the important factors of production has been in great need of institutional mechanism to be both utilized effectively and efficiently. Since early 1990s, the reform of urban land market in an economy of transition in China was initiated from plan-controlled to market-led orientations. This paper examines the relationship between land price and site density restrictions such as floor-to-land area ratio (FAR) and other factors with empirical analysis on public land leasing in Beijing, China. The effectiveness of land use regulations and government intervention in the market is also studied as to provide policy implications for China and other countries in transition to market economy.

Key words: urban land restriction transition China

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I . INTRODUCTION

Restrictions on site density at which development would occur have long been regarded as an important tool of land use regulation, especially in previous planned economies like China. In the transition from centrally planned economy to market economies, the function and effects which land use planning and regulations generate during this process have been understudied in the empirical literature. With the emerging land market in Beijing and the availability of land transaction data make it possible of more empirical analysis on the relationship between land value and site density restriction in transition economies, as well as the impacts of land use regulations of both municipal and district government on the structure density of real estate development. In this paper, a methodology to identify the degree to which restrictions on the ratio of floor area to ground space (also know as floor-to-land area ration, FAR) constrain real estate developments. By measuring the effects of allowed FAR on the land prices, we may see how the incentives facing with governments on land use regulation and development density control may affect market outcome in the urban development and redevelopment of Beijing, China.

The setup of this paper is as follows. Section II describes the background of Beijing land market reforms and the role of government regulations in this process. In Section III, literatures on land use regulations, site density restrictions and zoning as well as land value in transition economies are reviewed. Section IV presents the theoretical foundation and the methodology of estimating the effects of site-specific density restrictions and test the impacts of density regulations on urban land value. In Section V, empirical application of the methodology is implemented by examining the coefficients of density restriction on land transaction prices. Policy implications on the land use regulations of land administration authorities and government decisions are derived from the empirical results. Section VI provides conclusions and suggestions for future research.

II. LAND MARKET REFORMS AND GOVERNMENT REGULATIONS IN BEIJING

The Beijing municipal government administers 18 counties or districts. Four of them called inner city district are: *Xicheng, Dongchen, Chongwen, and Xuanwu*. These four districts just slightly exceed Beijing's defense walls that were destroyed during the Cultural Revolution. The boundaries of Beijing defense walls also delineate the "old city", which was the capital for both Ming and Qing dynasties. The "old city" occupies land of about 62 square kilometers with about 1.8 million populations. Another four districts called outer city district are Haidian, Chaoyang, Fengtai, and Shijingshan. These four districts were the primary areas of land development from late 1970s. These eight districts cover the majority of the 1992 planned areas. Areas that are close to city areas in Daxing, Tongzhou, Shunyi, Mentougou, and Changping also experienced land development on a smaller scale than in the four outer city districts. The remaining counties (Fangshan, Pinggu, Huairou, Miyun, and Yanqing) were considered to be far suburbs and had far less economic connections with the city core. (Figure 1)

The Beijing municipal government has invested massively in infrastructure in the last couple of decades. Beijing city follows relatively strict symmetric pattern centering Tiananmen Square in ancient times. With the urban development in the past decades and the evolution of city function, the economic center known as CBD has moved to the Chaoyang District which is 5-10 kilometers from Tiananmen Square. City's expressways also known as Ring Roads are concentric rectangles to Tiananmen Square. The fifth ring road is just open and sixth ring is currently under construction. In addition, the subway system expanded farther to the east, significantly reducing the commuting time to the city core. Large number of urban construction was initiated after Beijing's successful bid for the 2008 Olympic Games, which would have outstanding impact on housing and land markets in Beijing.

Land as known to all is owned by the state in Chinese cities, yet the government began to introduce market reforms which permitted leasing of public land and transaction of land use rights (LURs, 70 years for residential, 40 years for commercial and 50 years for industrial and mixed uses). Land markets in Beijing started to emerge in 1992 but sales of land use rights grants did not really take off until 1997. (Figure 2) The leasing of public land not only attracts private capital to develop needed housing and commercial estates in the city but also brings large sum of land sale revenue for public finance such as infrastructure construction and resettlement of residents and factories displaced by redevelopment (Fu and Somerville, 2001). The municipal government's Land Assembly Center administers the leasing and transaction of land use rights and regulates land market by monitoring the overall supply of development site and the land use densities across the city. The density regulations are expected to reflect the effects of competing land use and the bargaining power among different groups of interests. These effects should be relevant to the impact of site specific density restrictions upon different objectives of the land administration authorities, as well as the characteristics of the site and local district.

Examination on the effects of development density or FAR to the land value reveals the sensitivity of real estate markets to land use regulations and political atmosphere. The net benefit of land leases is not evenly distributed between the municipal and district government. In order to maximize the land lease revenues, both governments have the incentives to loosen the restriction on site densities. The district governments retain fiscal benefits and have to deal with resettlements of displaced residents, while municipal government obtains revenues from land leasing to finance public infrastructures to alleviate the agglomeration pressure of urban growth and shares larger part of externalities of increase development density. Evaluating the effects of density restrictions on land value would offer insights to both district governments and municipal government to minimize inefficiencies and facilitate policy-making process and sustainable development.

III. LITERATURE REVIEW

There are a number of theoretical and empirical literatures on land use regulation, zoning and urban land value in transition economies. The theoretical zoning literature includes a variety of papers that look at the effects of zoning regulations that restrict development density, measured by the capital-to-land ratio, on outcomes and social welfare. Under competing assumptions Rolleston (1987), Hanushek and Quigley (1990), Dubin *et al.* (1992), and Brueckner (1998) examined that zoning as exogenous factors affects the land use pattern, while Wallace (1988), McMillen (1989), McMillen and McDonald (1991), Pogodzinski and Sass (1994), and Thorson (1994) treated zoning as endogenous factors. This paper follows the endogenous assumption in which zoning or land use regulations is an on-going negotiation process between developers and land administration or planning authorities, and broadens the horizon of relationship between site density regulations and urban land value.

The literature has also examined extensively the questions of developing land market (Fu and Somerville 2001, Dowall and Leaf 1991, Dowall 1992b, Dowall 1993a, 1993b, Gaubatz 1995, Leaf 1997, Li 1999, Wu and Yeh 1999, Wu 1997, Wu 1995, Yeh and Wu 1995, Yeh and Wu 1996). Empirical studies have shown that even though developing countries have their own unique set of industrialization and urbanization trajectories that do not exactly replicate ones experienced in developed cities, it is observed that there is a remarkable similarity in urban spatial structure between developing and developed countries (Dowall and Leaf 1991, Dowall and Treffeisen 1991, Dowall 1992b). Land values, population density, and land use intensity tend to decrease away from urban centers, resulting from a tradeoff between accessibility and housing and/or land prices in a maximization of residents' utilities. Evidence supports the notion of land-capital substitution in emerging land markets (Dowall and Treffeisen 1991), which marks the impacts of price mechanisms on land development.

IV. THEORY

Theory foundations of this empirical analysis consider and measure the effects of site-specific density or FAR restrictions of the urban land value. The theoretical illustration started with the development density or FAR h , which is expressed as a function of the ration of capital K to lot size L , assuming constant returns to scale in the production of real estate space Q .

$$h \equiv Q/L = F(K/L, 1) \equiv f(S) \quad (1)$$

where $S=K/L$ is the structural density, and the production function $F()$ is concave and homogenous of degree one. Inverting $h=f(S)$ to get $S=f^{-1}(h)$, we will have the cost function for development density:

$$c(h) = iS = if^{-1}(h) \quad (2)$$

where i is the price of capital. The marginal cost of development density is

$$c'(h) = i/f'(S) = i/F_k > 0 \quad (3)$$

Since $F()$ is concave, taking the second derivative and the marginal cost of development is increasing in h :

$$c''(h) = (-i/f''(S)^2)f''(S) > 0 \quad (4)$$

Under perfect competition, free market entry drives profits of developing a site to be zero, which implies:

$$v = p(X)h - c(h) \quad (5)$$

where v is land price, and $p(X)$ is the market price of floor space, and thus the marginal value of development density v_h is

$$v_h = p(X) - c'(h) \quad (6)$$

To do empirical analysis a rate of technical substitution (RTS) is introduced, in which

$$RTS = F_L/F_K = (1/i)[h \cdot c'(h) - c(h)] \quad (7)$$

Substituting $c(h)$ and $c'(h)$ from equation (5) and (6) we have

$$v_h = (1/h)(v - i \cdot RTS) \quad (8)$$

Assuming $i = 1$ and Cobb-Douglas production for floor space, $F(K, L) = \alpha K^\lambda L^{1-\lambda}$,

$$\text{RTS} = [(1 - \lambda) / \lambda](h / \alpha)^{1/\lambda} \quad (9)$$

And $z = (\text{RTS}/h) / (1 - v_h/z)$ (10)

Where $z = v/h$ is the land price per square meter. Taking logarithm of each site and through mathematic transformation, we have

$$\ln(z) = a + b \cdot \ln(h) + v_h/z \quad (11)$$

where v_h/z is a linear function of location attributes X plus random error ε , so that $v_h/z = X \cdot \gamma + \varepsilon$, where γ is a vector of coefficients. This results in a reduced form of estimating equation for the following empirical analysis:

$$\ln(z) = a + b \cdot \ln(h) + X \cdot \gamma + \varepsilon \quad (12)$$

where in the regression equation the estimated coefficients in b represents the effects of site density restriction on land prices and γ indicates the spatial variation across sites under the constraint of site density.

V. EMPIRICAL ANALYSIS

A. Data

The data consists of 103 land leases granted by Land Assembly Center of Beijing municipal government from 2003 to 2005. For each site, we know the location, transaction land price, lot size, current condition of land, and the permitted land use and maximum allowed density FAR of structures to be developed at the site. Land use patterns differ from different districts and the observations are mainly occurred in the outer city districts and few redevelopment cases in the inner ones due to urban sprawl and the historical preservation.

The land lease prices are a negotiation process in China. Lack of negotiating skill or rent-seeking behavior by government officials could result in land lease prices that are biased measures of market values. One goal is to examine the variation in land prices

across locations. As long as any distortion in the land lease prices is orthogonal to the variables of interest, estimates will not be biased. Focusing on the relationship between the restrictions on site density and land prices would be of great value to the evaluation of land use policymaking and the development of land market in transition economies. Following is a table of variable definitions in the regression.

Table 1
Variable Definitions

lnPpsm	Log of transaction land price per square meters
lnFAR	Log of floor-to-land area ration (FAR) as a measurement of site density
DCBD	Distance to the Central Business District of Beijing (in 10 km)
lnLapc	Log of living area per capita in different district as a proxy to the living conditions of residents in certain district
Dring	Distance to the nearest Ring Road (in 10 km)
Resi	A dummy variable indicating whether the site is planned as a residential project
Develop	A dummy variable indicating the current condition of whether the lot has basic public utilities (1 if yes, 0 if no)

Descriptive Statistics

	Min	Max	Mean	Std. Dev.
Land Price (10,000RMB)	33	117500	19123.86	26895.06
Unit Price (RMB/M ²)	101.36	54676.58	5967.63	9611.19
FAR	0.18	9.59	2.17	1.87
Dis. To CBD (Kilometers)	2.86	70.25	25.50	15.12
LAPC (M ²)	12.9	40	23.26	5.82

1 US dollar = 8.28 RMB

B. Empirical Specification

The goal of this empirical application is to identify the impacts of constraint in development density on the urban land value, through which land use regulations of government affect the market outcome. It is expected that constraining site density would result increasing land price and the coefficients of FAR should be positive according to theory. In the set of location attributes, some basic measurements such as distance to CBD, land conditions and land use types are included. For the Distance to CBD negative sign of coefficient is expected as the land value decrease spreading out from the city center, while better land condition would have positive impacts on land value. Coefficients of independent variables are estimate in the regression results.

Yet, the results in this regression may suffer from the traditional simultaneity bias. The simultaneity problem arises because the regressors are endogenous and are therefore likely to be correlated with the error term. Hausman specification test can be used for testing this problem. In this empirical analysis, the land price z and the allowed FAR h hence RTS are jointly determined through land lease negotiation process. The regression error ε in Eq. (12) represents the noise in density constraint v/z rather than in land price z , so it is not expected to be correlated with RTS. To ensure that our estimates are not biased due to potential simultaneity, instrumental variables for $\ln\text{FAR}$ such as the distance to the nearest Ring road, distance to CBD, log of living area per capita, a dummy indicating whether it is a residential development and a dummy of land current conditions, ensuring that there in no multicollinearity among the instrumental variables. A two-stage least square (TSLS) is introduced to compare with the OLS estimate result.

C. Regression Results

The empirical analysis first estimates Eq. (12) using $\ln\text{Ppsm}$ as the dependent variable, and $\ln\text{FAR}$, DCBD , $\ln\text{Lapc}$ and Develop as independent variables with OLS estimates and White correction for heteroscedasticity. Regression result is in Table 2. As the

result shown shows, all coefficients of independent variables are significant and with expected signs. The estimate of coefficient of $\ln\text{FAR}$ is positive related to $\ln\text{Ppsm}$, which holds in our expectations. This means loosening site density restriction will significantly increase in land prices. A negative coefficient of DCBD is also indicating the decreasing trend of urban value from the center.

To implement TSLS estimates, in Stage 1 we first regress $\ln\text{FAR}$ on the set of instrumental variables using OLS. The estimates of coefficients on DCBD and Develop are of expected sign and statistically significant. In Stage 2, the new instrumental variables will be uncorrelated with the error term of the endogenous variable. Regression result on the $\ln\text{Ppsm}$ of other independent variables as in simple OLS is in Table 3. As predicted, the coefficient on the determinants of the restrictions on density as $\ln\text{Lapc}$, DCBD and Develop are largely unchanged, but the imperfect instruments for the FAR means statistical significance failure, which is consistent with the finding of Shanghai in Fu and Somerville (2001). The adjusted R^2 of TSLS estimate fall to 0.58 compared with simple OLS estimate, which may partly account for the potential simultaneity bias.

VI. CONCLUSION

In this paper we present a methodology for measuring and analyzing the variation in density restriction on individual urban development sites. This allows a site specific estimate of the constraints imposed on developments. The methodology is applied to a unique set of data covering long-term leases for urban development and redevelopment sites in Beijing. It is found that the measured deviation of development density from its unconstrained level is consistent with a set of tradeoffs faced by the regulating authorities. The methodology for measuring the constraint makes these empirical results reliable; absent these restrictions, the observed FAR would be sufficient to explain the variations in land prices. Thus the relationship between site

density restriction and land value is examined through this empirical study. Meanwhile, this study also provides us with land use policy implications in China as to adjust to the market reform, upon which land use regulations and government intervention have significant impacts on the market reform.

This study may provide insights for the study of urban land market in transition. Future work on this topic may advance having more observations on land transactions and the better identification of instrumental variables to eliminate simultaneous bias and understanding of estimate results from different perspectives. The proper selection of instrumental variables is always of great importance in TSLS, as well as proper measurement of market performance. The process of experimenting on the variable affecting certain variables like FAR is of great value to this area, which requires further research with great effort.

Figure 1 Historical Development of Beijing City

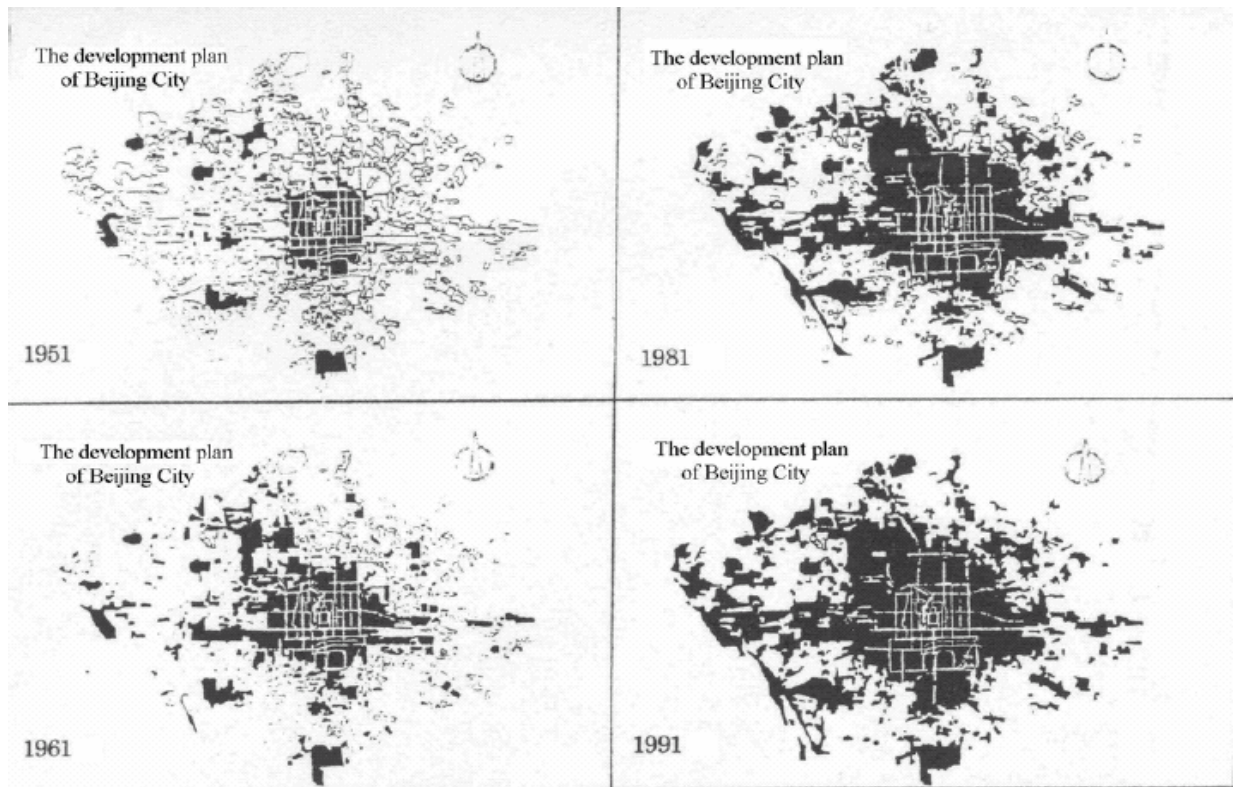


Figure 2 Land Development in Beijing

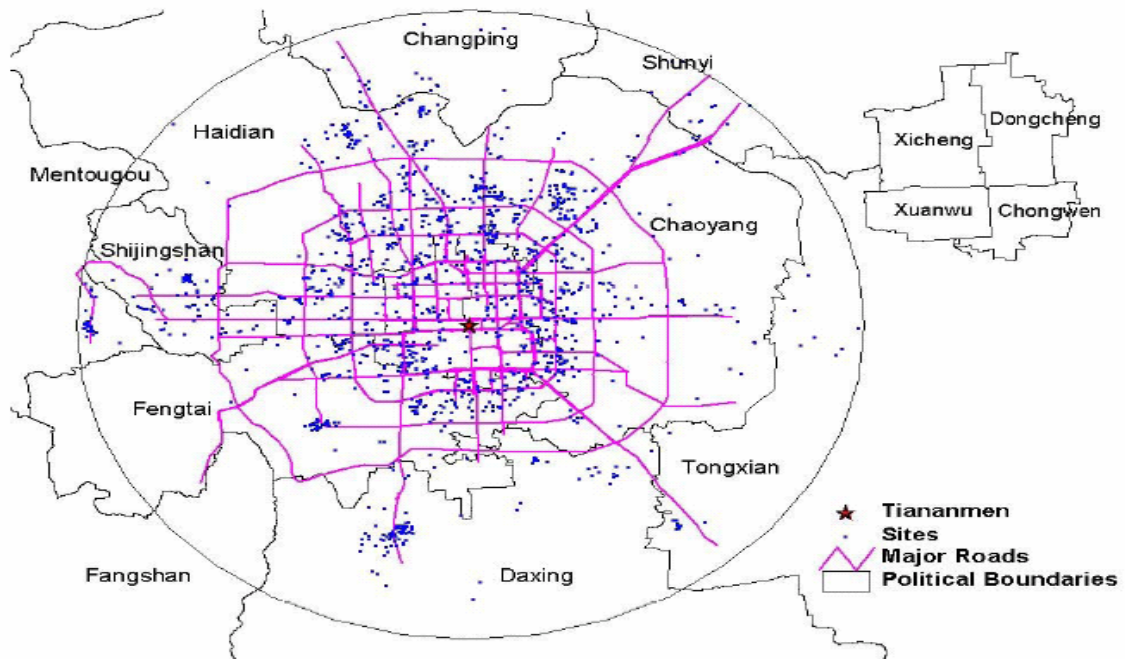


Table 2

Dependent Variable: LNPPSM

Method: Least Squares

Sample: 1 103

Included observations: 103

White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFA	0.9985030	0.136131015	7.334868253	6.46542221559434e-11
DCBD	-0.2574428	0.055838603	-4.610480818	1.21343333726099e-05
LNLAPC	0.9892311	0.344372605	2.872560549	0.0049915085760484
DEVELOP	0.9580376	0.202259588	4.736673739	7.34267264864295e-06
C	4.2699539	0.950542955	4.492120964	1.93011615611718e-05
R-squared	0.7078094	Mean dependent var		7.72868704322369
Adjusted R-squared	0.6958832	S.D. dependent var		1.44549866777892
S.E. of regression	0.7971459	Akaike info criterion		2.43176793268899
Sum squared resid	62.273282	Schwarz criterion		2.55966739813703
Log likelihood	-120.23604	F-statistic		59.3493869227461
Durbin-Watson stat	1.9294803	Prob(F-statistic)		2.34477241551374e-25

Table 3

Dependent Variable: LNPPSM

Method: Two-Stage Least Squares

Sample: 1 103

Included observations: 103

White Heteroskedasticity-Consistent Standard Errors & Covariance

Instrument list: DEVELOP DRING DCBD RESI LNLAPC C

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNFA	0.3277664	0.888775714	0.368784200	0.713084096994822
LNLAPC	1.2701186	0.576245156	2.204128922	0.0298558846877187
DCBD	-0.3392488	0.123998035	-2.735921414	0.00738567966304421
DEVELOP	1.3066822	0.525400384	2.487021806	0.0145714206942763
C	3.7156309	1.431959336	2.594788065	0.0109171116502524
R-squared	0.5982894	Mean dependent var		7.72868704322369
Adjusted R-squared	0.5818931	S.D. dependent var		1.44549866777892
S.E. of regression	0.9346765	Sum squared resid		85.614789394603
F-statistic	28.417625	Durbin-Watson stat		1.52571628223334
Prob(F-statistic)	1.1197e-15			

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