Land Value Determination in an Emerging Market:

Empirical Evidence from China

Helen X. H. Bao[1][*] , John L. Glascock[1] and Sherry Z. Zhou[2]

[1]*Department of Land Economy, University of Cambridge, CB3 9EP, UK*
[2] *Department of Management Sciences, City University of Hong Kong, Hong Kong*

Abstract

A key asset that is important in international markets is real estate—raw land and developed properties. Also, real estate can clearly have difference local rules for investment and transactions based upon bankruptcy protection, appraisal standards, lending standards, taxation and planning processes across countries. This can be particularly true when assessing a developing country. In this research, we assess the relative pricing behavior for land in Beijing China. We see this as important for three core reasons. First, China has a strong growth economy but is still in many ways an undeveloped country and thus we do not have significant data about asset pricing behavior there. Second, China has not traditional had a market based land and property transfer system—thus, it is interesting to assess how prices are determined relative to typical market expectations. Third, we have extensive evidence on pricing behavior in the USA and Europe but little such evidence on China—are the same variables important in Land pricing in China and are there other unique local variables. For example, there have been 22 articles published in core journals on Chinese land and only two provide empirical estimates of value attributes and none of there are as extensive as our study.   Thus, we consider a large data set of land prices in Beijing China and assess the relative pricing behavior.

Our key results are that pricing behavior in general follows the traditional expected variables as determined by size, planning use, location and other neighborhood characteristics. However, we also find that land prices are associated with buyer characteristics; for example, foreign investors pay less than local investors.

Keywords: semi-parametric, kernel, nonparametric, hedonic price modeling

Draft: 26 July 2007

---

[*] Corresponding author (hxb20@cam.ac.uk).

Land Value Determination in an Emerging Market:
Empirical Evidence from China

1.0   Introduction

Real estate is an important local and international asset estimated to be about 55 percent of world assets not including human capital. Real estate has also been an important part of China's growth and has posed interesting challenges in that China until recently recognized no public market for real estate or related assets (e.g., development rights).   An important part of real estate markets is the differing set of local rules for investment and transactions based upon bankruptcy protection, appraisal standards, lending standards, taxation and planning processes across countries.   This can be particularly true when assessing a developing country such as China.   In this research, we assess the relative pricing behavior for land in Beijing China. We believe that this is important for three core reasons.   First, China has a strong growth economy but is still in many ways an undeveloped country and thus we do not have significant data about asset pricing behavior there.   Second, China has not traditional had a market based land and property transfer system—thus, it is interesting to assess how prices are determined relative to typical market expectations. Third, we have extensive evidence on pricing behavior in the USA and Europe but little such evidence on China—are the same variables important in land pricing in China and are there other unique local variables[1].   There is also a scarcity of evidence from China. For example of the 22 key articles published on land in the last five years, only two article shave provided empirical estimates.   And those two articles are not as extensive in their data or analysis as this research.   Thus, we consider a large data set of land prices in Beijing China and assess the relative pricing behavior.

Our key result is that pricing behavior in general follows the traditional expected variables as determined by size, planning use, location and other neighborhood characteristics.   We also find that land prices are associated with buyer characteristics; for example, foreign investors pay less than local investors[2].

The paper is organized as follows.   In section 2 the literature of land value determination is reviewed.   Section 3 outlines the hypotheses to be tested and the research design.   Section 4 gives details of the data and empirical models used in our

---

[1] For example, although foreign direct investment is encouraged in China, it is highly regulated in real estate development area.   On 6 March 2007, the Ministry of Commerce of the PRC issued some instructions on attracting foreign investment in 2007.   It is clearly stated that real estate is one of the sectors where foreign investment is strictly restricted. (Source: http://www.mofcom.gov .cn/aarticle/b/f/ 200703/20070304485330.html).

[2] We caution readers to be aware that this may be that the SOEs have bought a different bundle of goods than local investors that may not be captured by our explanatory variables. Later in the text we, argue that this may be true.

analysis. The empirical results are presented in session 4. Section 5 provides an overall discussion and Section 6 provides the conclusion.

2.0 Literature and Expectations

2.1 Background and Setting

China has gradually introduced market economy aspects into its once heavily centralized planning system and these reforms have effectively, along with strong economic growth, fueled strong urban expansion in China (Anderson and Ge, 2004). The central government first experimented with land right distribution to private users in 1987 in the costal city of Shenzhen[3]. Then, land values, or the premium payable to the government, were determined by private treaty between the government and potential buyers. Without a land market in place, the agreed price was unlikely to reflect the market value of the land[4]. The central government soon thereafter introduced additional means of land distribution – closed bidding (tender) and public auctions.

The central government recently pushed the sale of land use rights through tenders and auctions across major cities in China. The percentage of land right sales by private treaty drops steadily over years[5]. This more market-oriented land distribution system proved to be a double-edged sword: competition among potential buyers increased land (and house) prices.

There are extensive recent studies on China's land market (see, for example, Lin and Ho, 2003; Ma, 2002; Xie, Parsa and Redding, 2002; Ding, 2003, 2004 & 2007). The establishment of the land and housing markets in China has traditionally been a sensitive political matter because the ownership of the land by the people has been one of the key symbols of the communist system. However, land has been recognized by China's leaders as an important resource of economic activities. To accommodate the need for both economic development and political stability, the country adopted the

---

[3] Shenzhen remains an important city for China's real estate market. JonesLangLaSalle in their recent report on China 30 use Shenzhen as the comparison city to measure the top 30 second tier cities. Even through JLL (2007) stress the growth opportunities of the second tier cities, Shenzhen tops them in terms of property index and economic index values (see city evaluation table, page 3).

[4] This argument is supported by the recent work of Choy and Chau (2007) where they argue that SOEs generally have been and continue to be given discounts on their land purchases. Their work was on Shenzhen, but we believe this is applicable to other Chinese cities as well.

[5] In 2000 the percentage of land right sales by private treaty in China is 83.83%. This figure dropped to 63.34% in 2003 (China Land Resource Year Book 2001 & 2004).

leasehold property right system[6].   More specifically, because the country owns all land in China, the land use rights are granted to land users for fixed periods of time, determined by the planning uses of the land parcels.   Land users pay a lump sum premium to secure land leases from the government.   An additional annual nominal land use tax is also imposed.   In many cases this is to cover real maintenance and depletion costs associated with the property[7].   A secondary land market also developed to facilitate the exchange of land use right among lessees, which is essentially the transaction of land leases[8].

The significant economic growth in China's economy has also meant increased property values. These property value increases have attracted the attention of foreign as well as domestic investors. However a key concern is to what extent the values of property are market set?   China's long history of planning, ownership and control of land raises concerns by investors and researchers about the stability of property market. Our conjecture is that the land market in China has not reached a mature market-oriented stage[9].

In a market-oriented land distribution method, land values are determined by common factors such as those suggested by traditional urban economics theory and supported broadly by empirical findings.   However, the deep roots of the planning system and the nature of the communist system inevitably make uncertain the land value determination process in China.   Hence land values may also be determined by non-market factors as well as traditional market and institution forces.   In this research, we conduct an econometric analysis of the land value determination mechanism in China using data from Beijing.

---

[6] After China is established in 1949, land transaction had been illegal.   The Constitution is amended in 1988 to legalize the transfer of land-uses right. This marks the starting point of the land market in China.

[7] According to the 1988 Urban Land Use Tax Provisional Regulations the land use tax is 0.5RMB – 1RMB (1USD $\cong$ 8RMB) per square metre per annum in major cities.

[8] On 30 May 2001 the Ministry of Land and Resources P.R.C. released a guideline of regulating the China land market (http://www.mlr.gov.cn/pub/gtzyb/zcfg/tdglflfg/t20050406_66732.htm).   It stressed that the transfer of land uses right should be conducted in open market.   As a result, major cities in China started to establish land and property transaction centers to facilitate the transaction of land use rights.   For example, the Beijing land transaction centre is established on 28 Feb 2002 by the Beijing Land Resource Development and Reclamation Centre (http://www.bjtd.com/) to facilitate land uses right transactions.

[9] This is consistent with Choy and Chau's arguments (2007). They also argue that as markets are developed and there is less uncertainty as to land use (e.g., when major parts of cities have the development activity in place) they will be more market-based activities as opposed to government elated placements of land rights.

2.2   The Determinants of Land Value

Parcel size is traditionally recognized as an important determinant of land values. The parcel size gradient is essentially an indicator of the land subdivision and land assembly effects.   A convex structure, or a plottage effect, suggests there is a gain of land assembly. On the other hand, if land subdivisions cause land value per unit to decrease with parcel size, then a concave relationship, or a plattage effect, present itself. The prevailing view in the literature is in favour of a concave function form between parcel size and land value (see, for example, Colwell and Munneke 1997; Thornes and McMillien 1998).

There are also evidences suggesting a plottage effect of parcel size for small land parcels with relatively homogeneous characteristics (Lin and Evans 2000; Tabuchi 1996). The study by Colwell and Munneke (1999) provided an explanation of this puzzle by relating parcel size effect with location (e.g., distance to Central Business Districts). They found that land price per unit is negatively related to parcel size in most urban area except for the urban center where a positive relationship is observed.   Considering that Lin *et al* (2000) and Tabuchi (1996) used data from highly urbanized cities in Taiwan and Japan, it is not surprising that a convex structure was identified in their studies.

Location is a second traditional determent of value and generally serves as a proxy of the social and economic characteristics of the neighborhood of the land parcel. Early studies on land value determination usually consider the distance to the Central Business District as the single important factor (Kau and Sirmans, 1979; McDonald and. Bowman, 1979; McMillen, 1990, among others).   Box-Cox transformation (see, for example, Kau and Sirmans, 1979; McMillen, 1990) and polynomial regression (McDonald and. Bowman, 1979) are routinely utilized to detangle the relationship between the distance and land value. The empirical literature suggests that land values decrease consistently with the distance from the city center. Other measurement of location vary such as distance to airports (Colwell and Munneke, 1999; McMillen 1996), distance to the nearest train station (Tabuchi, 1996; Cervero and Duncan, 2004), and distance from the region boundary (Kowalski and Paraskevopoulos 1991). District dummy variables have also been used (Cervero and Duncan, 2004), to name a few. Consistently, land value is significantly influenced by location.

The use of location in land value functions is essentially an attempt to capture the social and economic environment of the land.   Although measurement such as distance to CBD is a good proxy of these factors, it is always preferable to quantify these factors directly in the model.   Some recent studies, benefiting from the increasing availability of information, consider a wide range of social-demographic attributes (Cervero and Duncan, 2004; Ihlanfeldt, 2007) and economic characteristics (Thorsnes, 2000; McMillen and McDonald 2002) in the effort of modeling land value. These factors are found to be helpful in explaining the land value determination mechanism in different jurisdictions.

The zoning regulation and planning restrictions are also determining factors of land value. Empirical evidences suggest that land use types (e.g., mixed use or single family residential uses) can claim a price premium in land transactions (Cervero and Duncan, 2004; Brownstone and Van 1991). Also it has been shown that density controls reduce the price of industrial land (Peiser 1989) and that government regulation of rent also influence the estimation of land value function (Pasha 1995).

In China land is owned by the government. There was no land market until late 1980s, when the central government initiated a pilot run of opening land market in Shenzhen, the southern frontier of China's open market policy. At the early stage land was distributed through private treaties between the government and buyers. Land values determined in these private treaties usually did not reflect its market value due to various political, social and economical considerations, and especially because the lack of knowledge of land value determination resulted by the planning system.

Given the high population density and unbalanced economic development in China, the land market is inevitably characterized by high density usage. High-raise apartment buildings dominate the residential property market. Even international retail giant Wal-Marts has settled for a three-storage building for its largest outlet in Asia instead of using its typical one storage layout. Without any government interventions, developers may trade living quality with profit maximization by building the maximum possible floor area on a given piece of land. To ensure a desirable living condition, the government has imposed density control in all land leases. The density control is usually specified in the form of plot ratios, which is essentially the ratio between floor area and parcel size. A larger plot ratio enables the developers to build more floor space, holding other elements constant.

Unlike in other freehold property right systems, the planning purpose or the usage of the land parcels is determined prior to the land transaction taking place. When municipal government has land parcels to be distributed by public auctions or tenders, information about these land parcels are released to the public. The published information includes the designated usage of the land (commercial, residential, industrial, or mixed), plot ratio, and other planning regulations. The change of any of these planning regulations such as switching an industrial land to residential land is subject to approval. Moreover, all land leases specify a maximum period before the developers start construction activities (usually 180 days). This does not allow much luxury of time for the developers to change land usage. Therefore the public auction and tender price reflect the price of a land parcel with a very specific usage.

Although China has been opened its door to the world for more than 20 years, the historic planning economy system is still deeply rooted in the country. The dominating role of state-owned companies in the national economy is one important example. It is still the fact that state-owned companies have the best access to financing. This is particularly important for land investment given the significant value involved in a typical transaction. Private owned companies typically cannot compete directly with

their state-owned counterparts. It is reasonable to expect that in public land auction state-owned companies have a better chance to win the auction because of their relatively larger size and easier access to capital.

To attract foreign investment to fuel the economic development in China, both central and municipal government have been setting up favorable policies to encourage direct investment such as setting up factories[10]. Besides conventional measures such as tax break and tax holidays, a discount on land price is also commonly used for this purpose. The ability of attracting foreign direct investment is also considered to be an important indicator that helps in getting promoted. Consequently, land parcels, and especially those for industrial usages, are leased to foreign invested companies with favorable price and/or lease terms.

3.0   Hypotheses and Models

3.1   Expectations

To summarize the discussion above, a market oriented land valuation system is still emerging in China and thus land value should be influenced by not only the 'usual suspects' such as size and location and regulations, but also by factors that of Chinese Characteristics such as buyer traits. To test this argument, the following hypotheses are set up.

Hypothesis [1]: Land value is determined by traditional characteristics: parcel size, location, planning usage and various neighborhood characteristics

Hypothesis [2]: State owned companies have both the ability and motivation to bid up the price: a dummy for state owned company should be significant

To test the hypotheses, it is important to correctly model the relationship between land value and its determinants. The relationship can be described by model (1) below.

$$Y = g(S) + f(D, N, U, B, T) + \varepsilon \qquad (1)$$

Where Y is a $n \times 1$ vector of land sales price, S denotes the parcel size, D is a $n \times k_1$ matrix of variables measure the location of the land parcel, N is a $n \times k_2$ matrix of neighborhood characteristics such as population density, industrial output and per capita GDP, U is a $n \times k_3$ matrix of dummy variables indicating the planning usage of the land, B consists of k_4 indicators of buyer characteristics such as the ownership

---

[10] See the review of China's tax incentive system in Chan and Mo (2000).

structure of the company, and finally, T is a $n \times k_5$ matrix of time dummies to capture land value movement over time. In Model (1) $f(D, N, U, B, T)$ takes a linear function form, whilst the relationship between land value and parcel size is described by an unknown function $g(.)$. Therefore (1) can be re-written as follows.

$$Y = g(S) + X\beta + \varepsilon \qquad (2)$$

where X is a $n \times k$ matrix combining D, N, U, B and T defined early, and $k = \sum_{i=1}^{6} k_i$. Given the functional form of $g(.)$ is unknown, model (2) can be estimated with a two-step semiparametric procedure suggested in Robinson (1988). A nonparametric estimator is adopted to obtain $E(X | S)$ and $E(Y | S)$ using X and Y as dependent variables respectively. β and $g(S)$ can be subsequently calculated with (3) and (4) respectively.

$$\hat{\beta} = [(X - E(X | S))'(X - E(X | S))]^{-1}(X - E(X | S))'(Y - E(Y | S)) \qquad (3)$$

$$\hat{g}(S) = Y - X\hat{\beta} \qquad (4)$$

If both $E(X | S)$ and $E(Y | S)$ are estimated using ordinary least squares method, (3) will give the OLS coefficient estimates of X and (4) will give the OLS coefficient estimate of S. Alternatively, $E(\cdot | S)$ can be estimated using a nonparametric estimator that offers more flexibility in the model building. The following discussion illustrated the procedures to obtain $E(Y | S)$ using a kernel estimator. It can be easily extended to multivariate cases such as $E(X | S)$.

Each element of $E(Y | S)$ is estimated by a weighted average of the value of Y, where the weight is determined by S. More specifically,

$$\hat{y}_i = \frac{\sum_{j=1}^{n} K\left(\frac{s_i - s_j}{a}\right) y_j}{\sum_{j=1}^{n} K\left(\frac{s_i - s_j}{a}\right)} \qquad (5)$$

where a is the smoothing parameter and $K\left(\frac{s_i - s_j}{a}\right)$ is the Gaussian kernel function. The smoothing parameter controls the smoothness of the estimation. If a

approaches zero the kernel function tends to interpolate the data, whilst a very large smoothing parameter gives raise to imprecise estimates. To select the optimal smoothing parameter the most commonly used method is minimizing the mean squared errors (MSE) by cross validation (see, for example, Anglin and Gencay 1996; Thorsnes and McMillen 1998).

$$MSE = n^{-1} \sum_{i=1}^{n} \left(y_i - \hat{y}_i^* \right)^2$$

where $\hat{y}_i^*$ is calculated using (5) by omitting y_i.

3.2   Data and Empirical Model

Beijing is the political and culture centre of the nation. It has a population of 10.85 millions and covers an area of 16,808 square kilometers. There are 18 municipal districts or counties in Beijing: four "inner city districts" (Dongcheng, Xicheng, Chongwen, and Xuanwu), four "outer city districts" (Haidian, Chaoyang, Fengtai, and Shijingshan), five "inner suburb counties" (Fangshan, Daxing, Tongzhou, Shunyi, Changping), and five "outer suburb counties" (Mentougou, Pinggu, Huairou, Miyun, and Yanqing). Figure 1 depicts the geographic distribution of these functional regions of Beijing. The inner city districts support the core functions of the capital. The central government and most of the foreign embassies are located in these four districts. Outer city districts hosts clusters of rapidly expending research and educational institutions. The eight city districts are the pillar of the economic and culture prosperity of Beijing. Compared with the city districts, the suburb counties have less economic connection with the city core. However, these regions have been growing rapidly by leveraging its rich ecological and tourism resources. The concentration of military units and the development of heavy industry in the western suburb counties also fuel the development of this region (Ding, 2004). The land market in Beijing is not balanced among its functional regions. City districts witnessed a rapid development, but land for the physical expansion in these areas is limited. On the contrary, suburb counties have bountiful land and lower population density; thus, there is ample space for the land market development.

[Insert Figure 1 here]

The social and economics statistics given in Table 1 reveal the differences among the four functional regions in Beijing. Clearly the suburb regions are less developed, confirmed by their low population density, fewer migrant workers, and less retail sales. The inner cities have the highest population density and the most migrants per kilometers, suggesting its strong standing in the social and economic activities in Beijing. Nevertheless, the development potential of inner cities is limited due to the fact that the regions have already been fully developed. The outer cities benefit from the larger land areas, the concentration of higher education institutions, and easy access to CBD due to

the fast expanding public transportation system. These suburb districts have been attracting a steadily growing amount of real estate development.

[Insert Table 1 here]

The data used in this analysis are land sales records in Beijing from January 2005 to November 2006. A total of 1,254 observations are collected. Since land sales through private treaty are usually not conducted under market rules, we only use tenders and public auctions land sales in our sample. The data set pools land sale records from the Beijing Municipal Bureau of Land and National Resources, social and economics statistics from the China Statistics Yearbook, buyer characteristics from the Tianjin AoKe QiTong Technology Development Ltd., and geographical information from the Longmap (Beijing) Ltd. Descriptive statistics of the variables are given in Table 2. Clearly the unit price in inner cities is the highest, followed by outer cities, inner suburbs, and outer suburbs. However, outer cities are the area where the most transactions were incurred, indicating a fast expansion of real estate development into these regions.

[Insert Table 2 here]

As a capital city, Beijing plays an important role in international affairs and serves as a center of politics and culture in China. It still has a prominent economic position but is gradually switching from a production center to a service center. As a result, land for industrial usage is declining, accounting for one-fifth of the developed land. Whilst in other major cities in China, this percentage of industrial land sales is much higher (Ding, 2004).

Although China has performed the economic system reform for more than a decade, most of the characteristics of planning economy still exist. State-owned companies are still the dominating china's economy. According to Table 2, roughly 50% of all the buyers are state-owned companies. Foreign invested companies only win less than 5% of the land sales. The rest of the land parcels are sold to privately owned domestic companies.

To test the hypotheses set up in session 3, the following regression models are estimated separately for industrial and non-industrial land sales.

$$
\begin{aligned}
luprice_{nonind} = \beta_0 &+ g(lsize) + \beta_1 lpratio + \beta_2 ld\_cbd + \beta_3 ld\_train + \beta_4 lcitysub \\
&+ \beta_5 dis1 + \beta_6 dis2 + \beta_7 dis3 + \beta_8 larea + \beta_9 lretail \\
&+ \beta_{10} lmigrants + \beta_{11} use\_com + \beta_{12} use\_mix + \beta_{13} fi \\
&+ \beta_{14} private + \beta_{15} quarter1 + \beta_{16} quarter2 + \beta_{17} quarter3 \\
&+ \beta_{18} quarter4 + \beta_{19} quarter5 + \beta_{20} quarter6 + \varepsilon
\end{aligned}
\tag{6}
$$

$$
\begin{aligned}
luprice_{ind} = \beta_0 &+ g(lsize) + \beta_1 lpratio + \beta_2 ld\_cbd + \beta_3 ld\_train + \beta_4 lcitysub \\
&+ \beta_5 dis1 + \beta_6 dis2 + \beta_7 dis3 + \beta_8 larea + \beta_9 lretail \\
&+ \beta_{10} lmigrants + \beta_{11} fi + \beta_{12} private + \beta_{13} quarter1 + \beta_{14} quarter2
\end{aligned}
$$

$$+ \beta_{15}quarter3 + \beta_{16}quarter4 + \beta_{17}quarter5 + \beta_{18}quarter6 + \varepsilon \quad (7)$$

The variables used in model (2) and (3) are defined as follows.

luprice _{*nonind*}	:	Logarithms sales price per square meter in 10,000 RMB for non-industrial land parcels (1USD ≈ 8RMB)
*luprice*_{*ind*}	:	Logarithms sales price per square meter in 10,000 RMB for industrial land parcels (1USD ≈ 8RMB)
lsize	:	Logarithms parcel size in squared meters
lpratio	:	Logarithms plot ratio
ld_cbd	:	Logarithms straight-line distance to the CBD in kilometers
ld_train	:	Logarithms straight-line distance to the nearest train station in kilometers
lcitysub	:	Logarithms straight-line distance to the nearest subway station in kilometers
dis1	:	Inner city districts (Yes=1)
dis2	:	Outer city districts (Yes=1)
dis3	:	Inner suburb districts (Yes=1)
larea	:	Logarithms district land area in thousand squared kilometers
lretail	:	Logarithms district number of employees in retail sectors in 10,000
lmigrants	:	Logarithms district migrants population in 10,000
use_com	:	Commercial usage (Yes=1)
use_mix	:	Mixed usage (Yes=1)
fi	:	Foreign invested company buyer (Yes=1)
private	:	Private domestic buyer (Yes=1)
quarteri	:	Quarterly time dummies, $i = 1,2,\dots,6$

Model (6) is estimated with non-industrial land sales only, and model (7) is constructed for industrial land transactions. Due to the different nature of these two types of land, the regressors included in these models are not identical. For commercial, residential and mixed usage land parcels, the distance to the nearest subway station, the nearest train station and the airport are used to quantify the location of the land parcel. However, the distance to subway station is not relevant to industrial land sales and consequently excluded from model (7). Similarly, the number of employees in retail sectors in each district is used in Model (6) to measure the business activity in each district. This is again not an influencing factor for industrial land value. On the other hand, migrant workers in China are still the most important supply of mobile labor force in most of the major Chinese cities. Industrial parks or areas with a high concentration of factories usually draw a large migrant worker population in the neighborhood. The migrant worker population size reflects, indirectly, whether a region has good infrastructure and labor forces to support industrial activities. Therefore variable *migrant* is included in model (7) but not in model (6). Modeling industrial land sales separately allows a better fit to the data. It also supports the notion that the land value determinants are different among different land usages.

To test hypothesis one, we expect to see significant coefficient estimates for parcel size, location variables, and neighborhood characteristics factors. Land price should have a concave relationship with parcel size, and a negative relationship with distance to essential landmarks (e.g., subway station for non-industrial land sales, and train station for industrial land sales). The social and economic characteristics of the neighborhood should have various impacts on land sales price as well.

To test hypothesis two, the coefficient estimates of variables *pi, private, pratio, use_com, and use_mix* should be statistically significant. It is expected that state-owned companies will pay more in land transactions because these firms have the financial background to bid up the prices; foreign invested companies are more likely to get favorable sales prices given the municipal pro-foreign-investment policies. Plot ratio should be negatively related to sales price per square meter, the economy of scale effect keeps unit cost down. Commercial land should be sold at a premium when compared with mixed and residential land parcels.

It is also expected that the quarterly dummies should be statistically significant as a group. The land price in China has been climbing steadily in our study period. Therefore the coefficient estimates of quarterly dummies should have positive signs.

4.0 Empirical Outcomes

Table 3 and Table 4 give the results of model (6) and (7) respectively. Each semiparametric model is compared with its parametric counterpart in terms of coefficient estimates, model fitting statistics and specification test. The sampling period covers two years. A total of 1,142 land sales in the first seven quarters are used for model building, and the last quarter's transactions ($n = 112$) are reserved to calculate out-of-sample MSE. The parametric benchmark models are estimated by specifying a linear functional form for $E(X \mid S)$ and $E(Y \mid S)$ in (3). It is equivalent to regressing Y on both X and Z using OLS method.

Overall the semiparametric models yield more precise coefficient estimates and smaller prediction errors. To verify if the semiparametric specification is valid, we adopted a Hausman-type specification test that is developed by Robinson (1988) and later applied to semiparametric estimation of hedonic price models by Anglin and Gencay (1996) and Thorsnes and McMillen (1998). The χ^2 test statistics are 1.4879 and 179.7668 for model (6) and model (7) respectively. Since $\chi^2_{0.01,21} = 38.93$ and $\chi^2_{0.01,19} = 36.19$, the null hypothesis of a linear functional form is rejected for model (7). More specifically, specification test indicates that the relationship between land value and parcel size is linear for non-industrial land, but non-linear for industrial lands. This finding is supported by the price-size patterns depicted in Figure 2 and Figure 3.

In Figure 2 the price-size relationship is close to linear; whilst the pattern in Figure 3 is obviously non-linear. Furthermore, the coefficient estimates using parametric and semi-parametric methods for non-industrial land are very similar (see Table 3). On the other hand, the parametric and semi-parametric coefficient estimates for industrial land shows greater discrepancy (see Table 3). This finding suggests that the price-size relationship is simpler for non-industrial land.

Since the specification test shows there is no difference between the parametric and semi-parametric models for non-industrial land prices, and that the semi-parametric model is better than the parametric counterpart for industrial land prices, discussions hereafter are based on the semi-parametric output.

4.1   Non-industrial land sales

For land parcels of non-industrial uses, the value is determined by the size, location and planning permission of the land. All neighborhood characteristic variables (e.g., AREA, RETAIL and MIGRANTS) are not statistically significant. In general these outcomes are consistent with other recent studies of Chinese land value determinants. For example, Ding (2004) also finds that the land price in Beijing is negatively related to the distance to CBD.

[Insert Table 3 here]

Figure 2 demonstrate the semi-parametric estimation of the price-size relationship for non-industrial land parcels and shows a convex relationship, e.g., unit land price drops as land parcel size increases. This is also supported by the negative coefficient loading of plot ratio (see Table 3 and the -0.3116 coefficient for LPRATIO and this is significant). Generally plot ratio determines the total floor space to be built on a site and a larger plot ratio tends to reduce the unit construction cost for these sites.

[Insert Figure 2 here]

We include commercial, mixed and residential property in the non-industrial land sample. The semi-parametric model identifies the hierarchy of these land uses in Beijing. We find that both commercial and mixed use land values are higher than residential land (see Table 3 for the coefficients of USE.COM for commercial and USE.MIX for mixed: both coefficients are significant) Land for residential use is less expensive than commercial or industrial.

Regardless of the planning uses, buyers prefer land parcels that are closer to the CBD, train stations, and the downtown subway network. Easy access to the subway system and CBD is important for both business and leisure. The railroad transportation system has been the primary mode for freight and passenger movement in China (Xie, Chen & Nash, 2002). In Beijing most of the train stations are located at convenient, sometimes even central, locations. It is not surprising to find that developers tend to pay a premium to acquire land parcels near these train stations.

Foreign investment companies pay less in tenders and public auctions for land use rights. In China, traditionally performance of a company is evaluated by its scale (e.g., total operating income) instead of profit. Because of this, Chinese companies will tend to be less profit oriented (see for example the discussion by Firth, Fung and Rui, 2006). Consequently domestic companies, private or state owned, are more motivated to expand their business rather than maximize profits. Therefore domestic companies are more likely to bid up the price in tenders and public auctions to obtain the land parcels. Foreign investment companies tend to be more profit-oriented and thus will stop bidding as the price appears to be too high.

Another possible explanation is that domestic companies have better access to financing through the state-owned banks. The tie between state-owned developers and banks is well recognized. What is not conspicuous to outsiders is the connection between private owned and state-owned land users. Most of the privately owned development companies are actually spin-offs of state-owned companies[11], or lead by people with close connection with the government. Therefore domestic companies generally have good 'Guanxi' with state-owned banks, which provide these companies with good access to funding for the land transactions. Thus, with better access to capital, it is not surprising that these state-related companies pay more for land than outside investors.

Our findings also suggest that the land value in Beijing were increasing steadily until the third quarter of 2006. There are at least two reasons contributing to the sudden downturn of land prices in Beijing. First, the number of sales in the third quarter of 2006 is almost doubled that of other quarters in the sampling period, indicating an increase in land supply in this period. Secondly, and more importantly, the central government announced several policies to dampen the over-heated property market, including a 20% value-added tax on property sales came into effect on 1 August 2006. The combined effect is a significant drop in land prices in the third quarter (e.g. quarter 7).

4.2   Industrial land sales

The land value determination mechanism for industrial land parcels is different in many aspects from non-industrial land sales. Although land value per squared metre is negatively related to parcel size, the nonlinear price-size relationship is much more obvious for industrial lands. Figure 3 depict the size-price relationship using a semi-parametric model. This suggests that unit land price increases with parcel size initially and then decreases thereafter. All else equal, the most expensive industrial land parcels in Beijing are roughly 1,000 squared meters in size (see Figure 3). We also find that land price is negatively related to the plot ratio. Also, notice that the magnitude of

---

[11] For example, Vanke Co. Ltd, the largest domestic real estate developer in China, is evolved from a state-owned company in Shenzhen.

the coefficient loading is much larger for industrial land: the coefficient estimates for plot ratio is -0.8845 for industrial land versus a -0.3116 for non-industrial land.

[Insert Table 4 here]

[Insert Figure 3 here]

Although we find that neighborhood factors do not influence non-industrial land values, neighborhood factors have a significant impact on industrial land values. From Table 4, we find that industrial land buyers are interested in land parcels in districts with more land supply (e.g., district with larger land area), less retail, and more migrant workers. Considering that industrial activities require significant storage spaces and an abundant supply of labor, this finding is not surprising.

Secondly, Table 4 indicates that foreign investment companies are not paying more compared with their domestic counterparts. From analysis not shown in the tables, we also find that industrial land prices are less than those of commercial and residential lands[12]. Also, industrial development has not been recently a priority in the Beijing area[13]. The politically sensitive domestic companies (private or state-owned) are understandably less interested in industrial land sales. Thus, the competition for land and the associated prices are lower in the Beijing for industrial land compared to commercial and residential land.

Distance to the CBD (or subways) was not found to be important in pricing industrial land. On the other hand, the being close to a train station has significant value (see Table 4—the coefficient of LD.TRAIN is -0.2558 and significant: this shows that the further away one is from the station the less valuable industrial land is). Unlike developed countries where air transportation moves the most of the freight, rail transportation system still handles most domestic freight in China (Xie, Chen & Nash, 2002). Consequently buyers pay a premium to secure land parcels that are close to rail transportation hubs. It is also clear that the most expensive industrial land parcels are located in the inner city region, whilst the cheapest ones can be found in the outer suburb districts.

The last observation from Table 4 is that the industrial land prices in Beijing have been relatively stable during our sampling period.

---

[12] In a preliminary analysis industrial and non-industrial land sales are pooled and modeled with regression method. Land use type dummies are included in the model to capture the price difference among different land uses. It is found that the coefficient estimate corresponding to industrial land use type has the smallest value among all land use type dummies. This indicates the industrial land value is the lowest in Beijing.

[13] In 2006, among the 59 major projects undertook by the Beijing Municipal Commission of Urban Planning (BMCUP), only seven projects are industrial development (www.bjghw.gov.cn).

5.0   Discussion

Although there has been fast-growing interest in the land and housing markets in China, empirical studies in this area remain scarce. In Table 5 we summarize publications on China's land market from seven major real estate journals[14] between 2003 and 2007.   Case study and qualitative analysis methods dominate the literature. The only two empirical analyses using statistical methods are Ding (2004), and Tan, Heerink and Qu (2006).   Ding (2004) is the closest one to this study.   In Ding (2004) a hedonic price model is constructed to study the land sale prices in Beijing from 1993 to 2000. However, industrial and non-industrial land sales are modeled together; only two factors (distance to CBD and planning uses) are considered in the hedonic regression model; the OLS technique adopted by the author does not allow flexible estimation of the hedonic price coefficients.   In Tan, Heerink and Qu (2006) a richer set of independent variables are included in the two regression models. But the purpose of their study is to understand the causes of land fragmentation, instead of the determinants of land value. Hence it is not directly relevant to our study.

In sum, there is clearly a call for empirical analysis on China's land market using quantitative methods.   Our study fills the gap in the literature in three ways.   Firstly, this paper analyzes prices of non-industrial and industrial land separately.   Our empirical findings support this approach by showing that the price determination mechanism is different for these two types of lands.   Secondly, a comprehensive set of land attributes are included in our empirical model.   This allows the hedonic price coefficients to be estimated more accurately.   Finally, a semi-parametric framework is adopted to allow flexible identification of the relationship between land prices and land traits.

[Insert Table 5 here]

6.0   Conclusions

Using data from Beijing, we investigate the land value determination in the emerging land market in China.   Two hypotheses are set up to verify the current status of China's land market.   Industrial and non-industrial land sales are modeled separately to better reveal the underlying land value determinants.   We find that an efficient land market is at work in China.   This is supported by the fact that most of the land value determinants identified in the urban economics theories and previous empirical studies are found significant in our analysis.   In Beijing land market price is determined by parcel size, floor space, location, neighborhood characteristics and planning uses. Nevertheless, evidences are also found that some "Chinese Characteristics" still exist. Foreign invested companies pay less to obtain land use rights through tenders and public auctions. State owned and privately owned domestic companies are scale-drive

---

[14] The journals surveyed are Land Use Policy, Journal of Housing Economics, Journal of Real Estate Finance and Economics, Journal of Real Estate Research, Journal of Urban Economics, Real Estate Economics, and Urban Studies.

instead of profit-driven. Their Guanxi with state owned banks also help them to finance the land transactions. These are some unique Chinese Characteristics.

In conclusion we find land value in China are determined by both market and non-market elements. It is very encouraging to see an effective land market in force. Land users determine the price to pay based on the characteristics of the land and its surrounding environment. The government is also able to use the similar information to determine the reserve price for tenders and public auctions. Of course, some unique factors should also be considered when determining the land value in China. Our conclusion is the land market in China is still an emerging market.

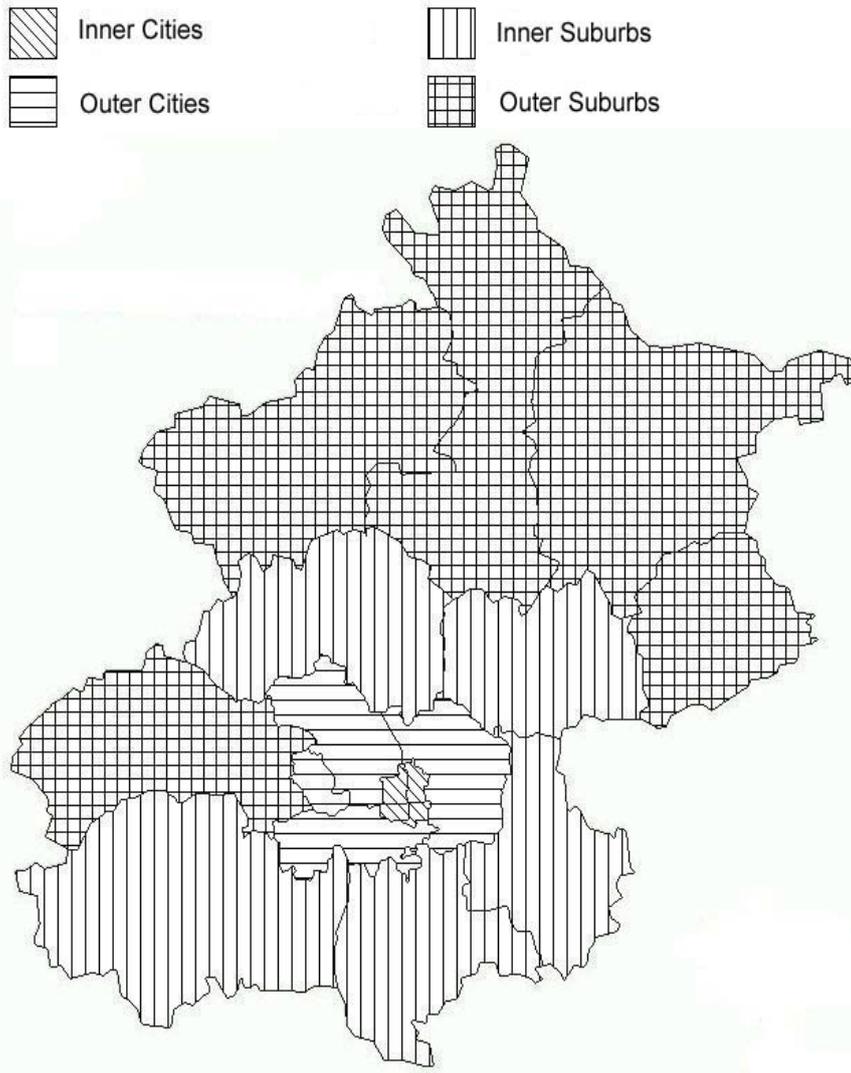**Figure 1 Beijing City and Its Four Functional Regions**

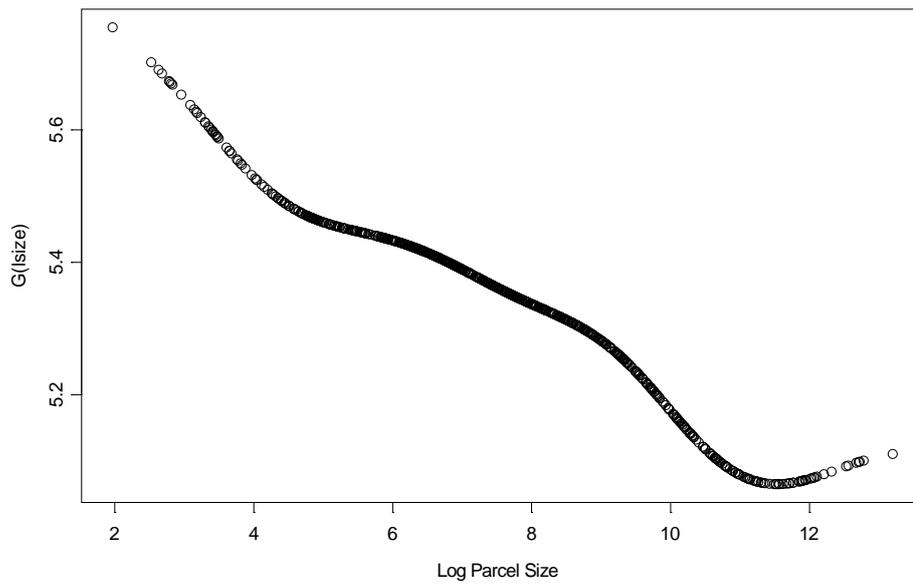**Figure 2 Price-size relationship (Non-industrial land)**
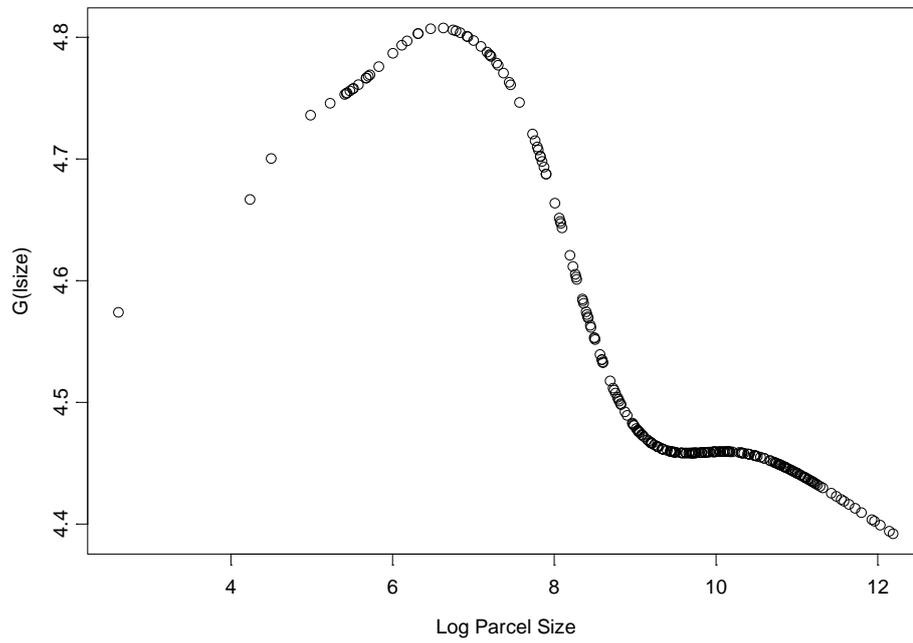

Figure 3 Price-size relationship (Industrial land)

Table 1 Social and economic statistics by functional regions

	Population (in 10,000)	Area (in km²)	Retail (in 100,Million RMB)	Migrants (in 10,000)
Inner cities	241.6	92.39	506.6	36.4
Outer cities	957.2	1275.93	1063.9	209.2
Inner suburbs	506	6295.57	264.7	94.4
Outer suburbs	190.5	8746.65	134.9	17.3

Source: China Statistics Yearbook,2004-2005

Table 2 Descriptive Statistics

Variables	Mean	Std Dev	Category
LUPRICE	6.22	1.09	--
$LUPRICE_{ind}$	5.28	1.16	--
$LUPRICE_{nonind}$	6.54	0.86	--
LSIZE	8.07	2.18	S
LPRATIO	0.22	1.22	S
LAREA	5.95	1.45	N
LRETAIL	8.86	1.09	N
LMIGRANTS	2.98	1.11	N
LD_CBD	2.59	0.94	D
LD_TRAIN	2.24	1.06	D
LCITYSUB	0.37	0.73	D
PRIVATE	46.09%		B
FI	4.39%		B
USE_RES	9.37%		U
USE_COM	49.36%		U
USE_MIX	15.95%		U
QUARTER1	11.72%		T
QUARTER2	11.88%		T
QUARTER3	11.64%		T
QUARTER4	10.77%		T
QUARTER5	10.05%		T
QUARTER6	10.61%		T

Table 3 Model estimation (Non-industrial land sales)

	Parametric Model		Semiparametric Model	
	Coef.	Std.Dev	Coef.	Std.Dev
INTERCEPT	5.8830**	0.5869	--	--
LSIZE	-0.0696**	0.0127	--	--
LPRATIO	-0.3142**	0.0230	-0.3116**	0.0236
LAREA	0.0260	0.0850	0.0287	0.0853
LRETAIL	0.1079	0.0708	0.1045	0.0709
LMIGRANTS	0.0853	0.0567	0.0805	0.0568
PRIVATE	-0.0088	0.0481	-0.0072	0.0481
FI	-0.3317**	0.1127	-0.3340**	0.1125
USE.COM	0.3306**	0.0661	0.3314**	0.0661
USE.MIX	0.2946**	0.0700	0.2965**	0.0700
LD.CBD	-0.2160**	0.0467	-0.2124**	0.0468
LD.TRAIN	-0.1002*	0.0485	-0.0980*	0.0488
DIS1	0.7422	0.5346	0.7859	0.5380
DIS2	0.4716	0.3364	0.5120	0.3399
DIS3	-0.0253	0.1496	-0.0084	0.1510
LCITYSUB	-0.1023**	0.0343	-0.1029**	0.0343
QUARTER1	0.1811**	0.0697	0.1712*	0.0703
QUARTER2	0.0564	0.0662	0.0483	0.0662
QUARTER3	0.1082	0.0663	0.1000	0.0666
QUARTER4	0.1823**	0.0722	0.1726*	0.0728
QUARTER5	0.2386**	0.0728	0.2272**	0.0728
QUARTER6	0.2887**	0.0729	0.2847**	0.0729
R Squares	0.5888		0.6017	
F Statistics	55.6367		61.6997	
In-sample MSE	0.3074		0.2981	
Out-of-sample MSE	0.2251		0.2199	
Specification Test (Robinson 1998)		1.4879		

*: Significant at the 5% level

**: Significant at the 1% level

Table 4 Model estimation (Industrial land sales)

	Parametric Model		Semiparametric Model	
	Coef.	Std.Dev	Coef.	Std.Dev
INTERCEPT	5.4630**	0.6526	--	--
LSIZE	-0.0663**	0.0147		
LPRATIO	-0.8808**	0.0183	-0.8845**	0.0185
LAREA	0.1893**	0.0762	0.2077**	0.0787
LRETAIL	-0.3257**	0.0790	-0.3139**	0.0791
LMIGRANTS	0.2499**	0.0496	0.2243**	0.0497
PRIVATE	0.0831	0.0501	0.0780	0.0497
FI	0.0339	0.1055	0.0314	0.1034
LD.CBD	0.0405	0.1022	0.0699	0.1013
LD.TRAIN	-0.2626**	0.0777	-0.2558**	0.0762
DIS1	3.3310**	0.5737	3.4233**	0.5834
DIS2	1.9013**	0.3131	1.9704**	0.3192
DIS3	0.9925**	0.1176	1.0072**	0.1199
LCITYSUB	-0.1148	0.0634	-0.1052	0.0625
QUARTER1	-0.1783*	0.0774	-0.1272	0.0784
QUARTER2	-0.1102	0.0793	-0.0978	0.0785
QUARTER3	-0.0228	0.0834	-0.0118	0.0824
QUARTER4	0.0424	0.0779	0.0890	0.0789
QUARTER5	0.0163	0.0818	0.0455	0.0811
QUARTER6	0.1504	0.0818	0.1677	0.0811
R Squares	0.9118		0.9210	
F Statistics	154.5609		184.4987	
In-sample MSE	0.1316		0.1183	
Out-of-sample MSE	0.0879		0.0827	
Specification Test (Robinson 1998)	179.7668**			

*: Significant at the 5% level

**: Significant at the 1% level

Table 5 Summary of academic papers on China's land market (2003 – 2007)

Paper	City / Region	Study period	Land type	Methodology
Cao (2007)	China in general	1950s onward	Mine land	Case study
Chen, et al (2007)	Fujian & Taiwan	1978 onward	Cultivated land	Case study
Cheng, et al (2006)	Wuhan Province	1950s onward	Urban land	Case study
Han and Wang (2003)	Chongqing	1990s onward	Urban land	Case study
Li and Li (2007)	Zhejiang Province & Hong Kong	Late 1990s - 2000s	Urban land	Case study
Zhu (2004)	Shanghai	1990s - 2000s	Urban land	Case study
Ding (2004)	Beijing	1992-2000	Urban land	Empirical study - OLS regression
Tan, Heerink, and Qu (2006)	Jiangxi Province	2000	Cultivated land	Empirical study - OLS regression
Long, et al (2007)	Yangtse River region	1987-2001	Rural housing land	Empirical study using spatial data*
Zhao, et al (2004)	Shanghai	1990 - 2000.	Natural reserve land	Empirical study using spatial data*
Deng, et al (2007)	China in general	1986 - 2000	Cultivated land	Empirical study using spatial data*
Tan, et al (2005)	Beijing, Tianjin, and Hebei	1990 - 2000	Urban land	Empirical study using spatial data*
Madelene and Chen (2006)	Shan'xi Province	2000 - 2002	Cultivated land	Empirical study using spatial data*
Ding (2003)	China in general	1949 onward	All land types in general	Qualitative analysis
Ding (2007)	China in general	1978 onward	All land types in general	Qualitative analysis
Ho (2006)	China in general	1990s onward	Forest	Qualitative analysis
Lichtenberg and Ding (2008)	China in general	Early 1990s onward	Cultivated land	Qualitative analysis
Lin and Ho (2003)	China in general	1996	All land types in general	Qualitative analysis
Wang, et al (2007)	North China	Early 1990s	Cultivated land	Qualitative analysis
Zhu (2005)	China in general	Early 1990s onward	All land types in general	Qualitative analysis

* These papers use satellite or GIS data.   The methodology adopted in these papers is simple and straightforward – descriptive statistics primarily.

References

[1]. Anderson G, and Ge Y. (2004), Do economic reforms accelerate urban growth? The case of China, *Urban Studies*, 41(11): 2197-2210.

[2]. Anglin, P. M. and R. Gencay (1996), Semiparametric estimation of a hedonic price function. *Journal of Applied Econometrics*, 11: 633-648.

[3]. Brownstone D. and Devany A. (1991), Zoning, returns to scale, and the value of undeveloped land, *Review Of Economics and Statistics*, 73(4): 699-704.

[4]. Cao, X. (2007), Regulating mine land reclamation in developing countries: The case of China, *Land Use Policy*, 24(2): 472-483.

[5]. Cervero R.; Duncan M. (2004), Neighbourhood composition and residential land prices: does exclusion raise or lower values? *Urban Studies*, 41(2): 299-315.

[6]. Chan K. H. and P. L. L. Mo (2000), Tax holidays and tax noncompliance: An empirical study of corporate tax audits in China's developing economy. *Accounting Review*, 75(4): 469-484.

[7]. Chen, J. F., S. Q. Wei, K. T. Chang, and B. W. Tsai, (2007), A comparative case study of cultivated land changes in Fujian and Taiwan, *Land Use Policy,* 24(2): 386-395.

[8]. Cheng, J. Q., J. Turkstra, M. J. Peng, N. R. Du, and P. Ho (2006), Urban land administration and planning in China: Opportunities and constraints of spatial data models, *Land Use Policy,* 23(4): 604-616.

[9]. Colwell P. F. and H. J. Munneke (1999), Land price and land assembly in the CBD, *Journal of Real Estate Finance and Economics*, 18(2): 163-180.

[10]. Choy, Lennon H. and K. W. Chau (2007), Initial Assignment of Property Rights in China Urban Land Markets, working paper, University of Hong Kong (presentation at Asian Real Estate Society annual meeting, Macau July 2007).

[11]. Deng, X. Z., J. K. Huang, S. Rozelle, and E. Uchida (2006), Cultivated land conversion and potential agricultural productivity in China, *Land Use Policy,* 23(4): 372-384.

[12]. Ding C. R. (2003), Land policy reform in China: assessment and prospects, *Land Use Policy*, 20(2): 109-120.

[13]. Ding C. R. (2004), Urban spatial development in the land policy reform era: evidence from Beijing, *Urban Studies*, 41(10): 1889-1907.

[14]. Ding C. R. (2007), Policy and praxis of land acquisition in China, *Land Use Policy*, 24(1): 1-13.

[15]. Firth M., P. M. Y. Fung and O. M. Rui (2006), Corporate performance and CEO compensation in China, *Journal of Corporate Finance*, 12: 693-714.

[16]. Han, S. S. and Y. Wang (2003), The institutional structure of a property market in inland China: Chongqing, *Urban Studies,* 40(1): 91-112.

[17]. Ho, P. (2006), Credibility of institutions: Forestry, social conflict and titling in China, *Land Use Policy,* 23(4): 588-603.

[18]. Ho S. P. S. and Lin G. C. S. (2003), Emerging land markets in rural and urban china: policies and practices, *The China Quarterly*, 175: 681-707.

[19]. Ihlanfeldt K. R. (2007), The effect of land use regulation on housing and land prices, *Journal of Urban Economics*, Forthcoming.

[20]. JonesLangLaSalle, China 30: China's Rising Urban Stars, 2007 report.

[21]. Kau J. B. and C. F. Sirmans (1979), Urban land value functions and the price elasticity of demand for housing, *Journal of Urban Economics*, 6(1): 112-121.

[22]. Kowalski J. G. and C. C. Paraskevopoulos (1991), The impact of location on urban industrial land prices, *Journal Of Urban Economics*, 27(1): 16-24.

[23]. Li, L. H. and X. Li (2007), Land readjustment: An innovative urban experiment in China, *Urban Studies,* 44(1): 81-98.

[24]. Lichtenberg, E. and C. Ding (2008), Assessing farmland protection policy in China, *Land Use Policy,* 25(1): 59-68.

[25]. Lin G. C. S. and S. P. S. Ho (2003), China's land resources and land-use change: insights from the 1996 land survey, *Land Use Policy*, 20(2): 87-107.

[26]. Lin T. and A. W. Evans (2000), The Relationship between the price of land and size of plot when plots are small, *Land Economics*, 76(3): 386-394.

[27]. Long, H. L., G. K. Hellig, X. B. Li, and M. Zhang (2007), Socio-economic development and land-use change: Analysis of rural housing land transition in the Transect of the Yangtse River, China, *Land Use Policy,* 24(1): 141-153.

[28]. Ma L. J. C. (2002), Urban transformation in China, 1949-2000: a review and research agenda, *Environment and Planning A*, 34(11): 1545-1569.

[29]. Madelene, O. A. and D. L. Chen (2006), Land-use change: Impacts of climate variations and policies among small-scale farmers in the Loess Plateau, China, *Land Use Policy,* 23(4): 361-371.

[30]. McDonald J. F. and H. W. Bowman (1979), Land value functions: A reevaluation, *Journal of Urban Economics*, 6(1): 25-41.

[31]. McMillen D. P. (1990), Consistent estimation of the urban land value function, *Journal of Urban Economics*, 27(3): 285-293.

[32]. McMillen D.P. (1996), One hundred fifty years of land values in Chicago: a nonparametric approach*, Journal of Urban Economics*, 40 (1): 100-124.

[33]. McMillen D.P. and McDonald J. F. (2002), Land values in a newly zoned city, *Review of Economics and Statistics*, 84(1): 62-72.

[34]. Pasha H. A (1995), Comparative statics analysis of urban land values in the presence of government regulation, *Urban Studies*, 32(9): 1505-1516.

[35]. Peiser R. B. (1987), The determinants of nonresidential urban land values, *Journal of Urban Economics*, 22(3): 340-360.

[36]. Saz-Salazar D. and S. L. Garcia-Menendez (2005), Public provision versus private provision of industrial land: a hedonic approach, *Land Use Policy*, 22 (3): 215-223.

[37]. Tabuchi T (1996), Quantity premia in real property markets, *Land Economics*, 72 (2): 206-217.

[38]. Tan, M. H., X. B. Li, H. Xie, and C. H. Lu (2005), Urban land expansion and arable land loss in China - a case study of Beijing-Tianjin-Hebei region, *Land Use Policy,* 22(3): 187-196.

[39]. Tan, S. H., N. Heerink, and F. T. Qu (2006), Land fragmentation and its driving forces in China, *Land Use Policy,* 23(3): 272-285.

[40]. Thorsnes P. (2000), Internalizing neighborhood externalities: the effect of subdivision size and zoning on residential lot prices, *Journal of Urban Economics*, 48 (3): 397-418.

[41]. Thorsnes P. and D. P. McMillen (1998), Land value and parcel size: a semiparametric analysis. *Journal of Real Estate Finance and Economics*, 17(3): 233-244.

[42]. Wang, X. H., C. H. Lu, J. F. Fang, and Y. C. Shen (2007), Implications for development of grain-for-green policy based on cropland suitability evaluation in desertification-affected north China, *Land Use Policy,* 24(2): 417-424.

[43]. Xie R., H. C. Chen and C. A. Nash (2002), Migration of railway freight transport from control economy to market economy: the case of China. *Transport Reviews,* 22(2): 159-177.

[44]. Xie Q., A.R.G. Parsa and B. Redding (2002), The emergence of the urban land market in China: evolution, structure, constraints and perspectives, *Urban Studies,* 39(8): 1375-1398.

[45]. Zhao, B., U. Kreuter, B. Li, Z. J. Ma, J. K. Chen, and N. Nakagoshi (2004), An ecosystem service value assessment of land-use change on Chongming Island, China, *Land Use Policy,* 21(2): 139-148.

[46]. Zhu, J. M. (2004), From land use right to land development right: Institutional change in China's urban development, *Urban Studies,* 41(7): 1249-1267.

[47]. Zhu, J. M. (2005), A transitional institution for the emerging land market in urban China, *Urban Studies,* 42(8): 1369-1390.