

Government Interference and the Efficiency of the Land Market in China

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Abstract Municipal governments in China established direct control of the supply of urban land in August 2004. This paper examines whether this government action mitigates the efficiency of the residential land market. Using a unique data set of detailed land and residential community transactions with manually collected location information for residential land lots in seven Chinese cities, this paper analyzes the relationship between the land lease prices and residential property prices from the first quarter of 2001 to the fourth quarter of 2007. Results indicate that property prices determined land prices both before and after 2004:3, but the effect was significantly weaker after 2004:3. This is consistent with the hypothesis that the market for residential land became less efficient after municipal governments gained direct control of the land supply.

Keywords: land market · government interference · market efficiency

JEL classification: G14 · H21 · Q15 · R52

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1. Introduction

Markets play an important role in allocating scarce resources. Government interference, for whatever reason, may reduce market efficiency. This paper investigates the effect that direct government control on the supply of land has on the efficiency of the Chinese urban land market. Muth (1969, 1971), among others, argue that the demand for land is derived from the demand for properties. Therefore, if both the land and the property market are efficient in the sense that transaction prices reflect market demand, land prices should depend on property prices. Empirically, this paper relates urban residential land prices in seven Chinese cities to residential property prices from the first quarter of 2001 to the fourth quarter of 2007 - both before and after the establishment of municipal governments' control of the urban land supply in August 2004. The main finding is that residential property prices play a significant role in explaining residential land prices both before and after the establishment of government control. However, the explanatory power of property prices is significantly weaker after the government established control of the land supply. Since there was no other known structural change in the residential property market in August 2004 and there is no direct government control on the demand for or the supply of residential properties in the entire sample period, it seems reasonable to conclude that residential property prices reflect the demand for properties both before and after August 2004. As a result, the weaker relationship between land prices and property prices after August 2004 is consistent with the hypothesis that direct government control on land supply reduced the efficiency of the residential land market in China.¹

The rest of the paper is organized as follows. The next section provides an overview of the market for residential land in China since 1949. Section 3 describes the data set. Section 4 presents the model specification and empirical results, and Section 5 concludes.

¹ We are unaware of any other major changes in the land market in 2004:3; therefore, it does not seem likely that the changing relationship between residential land and property prices was due to other structural changes in 2004:3.

2. The Market for Residential Land in China

The economy in mainland China was a planned, not a market oriented, economy from the establishment of the People's Republic of China in 1949 until the beginning of the openness and reform policy initiated by Deng Xiaoping in 1978. Rapid urbanization and economic growth triggered by the reform has been accompanied by the development of a market oriented economy in China. A market for land use also reemerged.² In 1988, China's constitution, which previously had prohibited all types of land transfers, was amended to permit land leasing while retaining public ownership of land. A local government's sale of a new leasehold interest is termed the granting of Land Use Rights (LURs) while a local government's sale of an existing leasehold interest is termed a Granted Land Use Right (GLUR) (see Peterson, 2006, and Cao and Keivani, 2008, for a complete discussion). In 1990, the State Council formally affirmed land leasing as public policy. By 1992, local governments in Shanghai and Beijing had adopted land leasing as local practice, and it began to spread to other cities.³ Land leases for residential properties in Chinese cities typically have 70 year terms (Zheng and Kahn, 2008).

Since all land is legally owned by the state, no private entities hold freehold interests in land. In our sample period, land is essentially jointly owned by municipal governments and its users. The reason is that, once a land lease is transferred from an existing user to a new user for a price, both the municipal government and the existing user share the revenue from the land lease transaction. In this paper, we call the existing tenant in land lease transactions the owner/seller and the new user the buyer. The way municipal governments and sellers share proceeds varies across regions, which suggests important location heterogeneity in the Chinese land market.

The land market has experienced some important changes since its re-emergence. Before 1999, land was transferred in one of two ways. First, the government could "re-allocate"

² See Ding (2003, 2004, and 2007), Zhu (2004, 2005), Su (2008) for more discussion of the reemerging land market in China.

³ Fu (1996) notes that between 1988 and 1991, the Shanghai government granted a total of 12 land leases; the number increased to 201 in 1992 and 3,000 in 1993.

the right of possession of a lot from the existing tenant, often a state owned enterprise, to a new user, also often a state owned enterprise. Money was not necessarily involved in this type of transaction. Further, in this type of land transaction it was often the municipal government that initiated the process and set the transaction price, if any, for the lease. This price typically did not reflect the economic value of the land. Second, potential buyers and sellers could search for each other and negotiate a price for the lease. Once a price was agreed by both parties, the land lease was exchanged, with the seller and the municipal government sharing the proceeds of the transaction. In this type of transaction buyers and sellers initiated the process and transaction prices were determined by the market for land. This market structure was essentially a search-based competitive market for land leases.

A new trading system called tender/auction/listing began to be adopted by some municipal governments in 1999 to process some land transactions,⁴ though not all municipal governments utilized the system to the same extent. In this trading system, municipal governments act as active sellers, and frequently put land “owned” by state owned enterprises on the market. The system is transparent as the characteristics of the land and final transaction prices are public information, and all potential buyers are permitted to make offers. The rationale of this system, according to the #11 Order of the Department of National Land Resources of the People’s Republic of China, which was issued in 2002 and mandated the adoption of this system by all municipal governments for all commercial and residential land lots, is “to regulate the transfer of state-owned land, to optimize the allocation of land resources, and to establish a transparent, fair, and just system of land transactions.” A main motivation for this trading system, according to Zheng and Kahn (2008), is that the central government is concerned about pricing frauds that can reduce government revenues from land lease transactions. For example, to reduce the fees paid to municipal governments, land buyers and sellers could collude and report prices that are much lower than actual transaction prices. Government officials

⁴ Tenders are often used by municipal governments to sell land directly occupied by them or by state-owned enterprises. Both auctions and listings are used for land “owned”/occupied by private entities. The main difference between auctions and listings is that offers are publicly observed and updated for listed lots over a much longer period of time (say a few weeks).

who are in charge of checking the reported prices could be bribed to overlook such frauds. Since municipal governments are the sellers in the tender/auction/listing system, and all price information is public, it is difficult for buyers and sellers to collude and report fraudulent prices. All land prices used in this paper are actual transaction prices from the tender/auction/listing system.

The tender/auction/listing system co-existed with the search-based competitive market until August 2004. This paper assumes that, prior to August 2004, prices of land leases traded in the tender/auction/listing system were comparable to prices in the search-based competitive market. Until August 2004, municipal governments did not have complete control on land supply despite the regulation (#11 Order of the Department of National Land Resources that became effective on July 1st 2002) requiring that municipal governments have plans for land supply via the tender/auction/listing system. Since buyers had the option to purchase land in the search-based market, similar land parcels in the search-based market and the tender/auction/listing system were likely sold for similar prices. Note that there likely existed interesting interactions between the two systems, which, however, are beyond the scope of this paper.

An important change to the Chinese land lease market took place in August of 2004. On March 31st 2004, Order #71 of the Department of National Land Resources required that, after August 31st of 2004, *all* land lease transactions *must* go through the tender/auction/listing system. As a result, the search-based competitive land market was eliminated. In the new market structure, municipal governments have direct control on land supply, as potential sellers must obtain permission from their local governments to list their land for lease and buyers can only make offers for land put on the market by local governments.

The post-2004 land market is characterized with possibly arbitrary and difficult-to-predict land supply that was dictated by municipal governments. Since market prices are essentially determined by the demand for and the supply of land, the arbitrary land supply may weaken the relationship between observed land transaction prices and the market

demand for land. As a result, land prices may be less informative in reflecting land demand, and in this sense the land market is less efficient.

We hypothesize that the Chinese urban residential land market became less efficient following the third quarter of 2004, even though it may have become more transparent and might more effectively mitigate fraud and corruption. We measure the efficiency of the land market using the relationship between residential land prices and residential property prices. Note that the demand for land is derived from the demand for properties, and it seems reasonable to assume that property prices reflect the demand for properties both before and after the third quarter of 2004. Therefore, we argue that, if the land market is efficient, the demand for land and thus land prices are higher when the demand for properties and thus property prices are higher. A weaker relationship between land and property prices indicates that land prices are less informative regarding the demand for land and that the mechanism for allocating land use is less efficient.

We test this hypothesis using a unique data set of residential land and property transactions in seven cities between the first quarter of 2001 and the fourth quarter of 2007. Using addresses and boundaries for traded land lots, we manually identify the district where each lot is located. The district information allows us to control for location heterogeneity not only across cities but across districts within city. We estimate a fixed effect panel model that relates land prices to the average and median prices of standardized properties traded at the same location and in the same quarter, controlling for some additional land and transaction characteristics. We find that property prices have explanatory power for land prices both before and after 2004:3. However, the explanatory power is significantly weaker following 2004:3. The results are robust to using the mean or the median of property prices, the use of contemporaneous or lagged property prices, and the exclusion of a possible transition period from 2004:4 to 2005:4, in which the relationship between land and property prices might be unusually low due to the market learning about the new system. These results are consistent with the hypothesis that the direct control on land supply by municipal governments established in August 2004 reduced the efficiency of land markets in China.

3. Data

Our analysis is based on 2,008 land lease transactions executed in the government tender/auction/listing system and 3,469 transactions of new urban residential communities in seven Chinese cities: Chengdu, Chongqing, Hangzhou, Nanjing, Shanghai, Suzhou, and Wuhan. The sample period is from January 2001 to December 2007. We obtain these 2,008 land transactions and 3,469 residential community transactions after filtering and cleaning a raw data set of land transactions in 25 cities and property transactions in 55 cities.⁵ We excluded cities that had fewer than 40 land transactions before August 2004, which resulted in data for seven cities.

Each land transaction in our sample has the following information: the city and the district where the lot is located,⁶ the transaction date, the transaction type (listing, tender, or auction), the transaction price, lot size (in square meters), the density of the lot (the portion of the lot occupied by the structure), the ratio of the square meters of the planned structure to the square footage of the lot, and the planned usage (residential or mixed use). Since all land transactions are executed through the tender/auction/listing system, the prices are accurate. Note that land transactions in our sample that took place before August 2004 are only a portion of all transactions during that period. However, the transaction prices in our sample should be representative of market prices, as the tender/auction/listing system co-existed with the search-based market and prices of similar lots in the two markets should be comparable.

Each residential community has the following information: the city and the district where the community is located, the type of the dwelling (condo, single-family home, townhome, or affordable condo), the sale date, the average price (RMB per square meter)⁷, the target market (domestic or foreign buyers), and the extent of interior

⁵ The data were purchased from GTA Information Technology Company in China.

⁶ The district information is manually collected by the authors.

⁷ It is worth noting that the condo prices are mostly presale prices. As Zheng and Kahn (2008) note, most condo projects in China (about 88% in their sample) are presold before the construction is completed.

improvements (no improvement⁸, basic improvements⁹, bathroom/kitchen improvements, partial improvements, complete improvements, or optional improvements on order). It is worth noting that our data consist of residential communities/subdivisions, not individual properties/units. While we do not know how many units each community contains, each condo community is estimated to contain approximately one to two hundreds units.

To mitigate possible biases due to land heterogeneity, we focus on urban land and urban residential communities, and exclude all transactions in rural areas. A lot or a residential community is considered urban if the district where the lot or the community is located is directly under a city's jurisdiction. We identify the district for each lot or community, and then determine whether this district is under the city's jurisdiction in the entire sample period. Since a large portion of land transactions do not contain district information, we manually identify the district for each lot by searching the boundary of the lot (often street names) on google.com. We then obtain a list of districts under city jurisdiction for each city by examining the city records in <http://www.wikipedia.org>. If a district is not recorded in wikipedia.org, we use google.com to search for municipal government websites to determine if the district is under a city's jurisdiction. We only keep land transactions for planned residential or mixed uses. For property transactions, we retain only residential communities.

Panel A in Table 1 reports the following summary statistics for residential land lease transactions in each of the seven cities: the number and the total value (in million of RMB) of land transactions, the mean, the median, and the standard deviation of transaction prices (in million of RMD), the total size (in 1,000 square meters), the mean, the median, and the standard deviation of lot size (in 1,000 square meters). The table shows that the number of land transactions varies dramatically across cities. For instance, Chongqing (with a population of 21 million) has 400 land lease transactions, while Wuhan (with a population of about 9 million) has only 169 transactions. The table

⁸ A unit with no improvements has no plumbing or electrical fixtures, no appliances, and the floors, walls and ceilings are unfinished.

⁹ A unit with basic improvements has plumbing and electrical fixtures and finished floors, walls and ceilings.

also shows significant variation in other characteristics. For example, the average land price varies from about 434 million RMB for Hangzhou to about 84 million RMB for Chongqing, and the total size of land transactions varies from over 29 million square meters for Chongqing to about 11 million for Hangzhou. The observed variation substantiates city heterogeneity in the land market that our empirical analysis will address.

Panel B in Table 1 reports the summary statistics for transactions of new residential communities in our final sample. The price of a residential community is calculated as the product of the average price per square meter and the total square meters of the community. Note that the table also indicates variation in the characteristics of communities across cities. For example, the number of communities varies from 1,660 for Shanghai (with a population of about 19 million) to 103 for Suzhou (with a population of about 6 million). Other property characteristics also vary dramatically across cities, which indicate significant location heterogeneity in residential communities.

Table 2 provides a summary of the property transactions, by property type, for each of the seven cities. Table 2 lists the number of residential communities sold and the mean transaction price, by property type (e.g. condo, townhome, single-family and affordable condo). For each city, the vast majority of properties are condos. Shanghai and Hangzhou had the most expensive residential properties while Chengdu, Chongqing and Wuhan the least expensive.

Table 3 reports the quarterly time series of land transactions. Several facts are worth noting. First, the sample contains more transactions after the third quarter of 2004 than before. This is likely due to the establishment of the mandatory tender/auction/listing system in August 2004, as our sample contains all land lease transactions after 2004:3 but only a portion of all transactions before. Second, the number of land transactions for each city varies dramatically over time. For example, Shanghai has 31 transactions in 2004:1, but 0 in 2004:2 and 0 in 2004:3. This is likely due to errors in the data: some land transactions in the data set lack trading dates. Note that the missing information

does not seem to bias the results in this paper, because the data errors appear to be due to mistakes made by the data vendor instead of the relationship between land and property prices.

Table 4 reports quarterly time series of new residential communities in our sample. The temporal patterns of residential communities appear to differ from the patterns of land transactions. The number of communities in a particular market tends to be more stable over time, which indicates the consistency of the property regulations and procedures, and possibly fewer errors in the data. Further, the market in some cities, such as Hangzhou and Wuhan, seems to be experiencing more growth during the sample period as the number of projects increases more dramatically in these places.

4. Empirical analysis

We use the relationship between residential land lease transaction prices and residential community transaction prices to measure the efficiency of the Chinese land market. Following the literature, we assume that the demand for residential land depends on the demand for properties. That is, prices developers are willing to pay for land are a function of what they expect property buyers will pay for completed properties in the future. Therefore, we assume that the land transaction prices depend on the expected property prices in the future.

$$\log(LP_{d,t}^i) = \beta \log(E_t [PP_{d,t+k}]) + \rho X_t^i + u_t^i \quad (1)$$

In equation (1), $LP_{d,t}^i$ is the transaction price of land lot i in district d in quarter t ; $PP_{d,t+k}$ measures the property prices in the district in a future quarter $t+k$, when the property on lot i is expected to be ready to sell; X_t^i is a vector of control variables that capture characteristics of the land and the planned residential communities on the land; and u_t^i is an error term.

We assume that $PP_{d,t+k}$ is a function of a measurement of current property prices $PP_{d,t}$ and the expected capital appreciation rate from quarter t to quarter $t+k$, $R_{d,t+k}$, and an error term $v_{d,t}$.

$$E_t [PP_{d,t+k}] = PP_{d,t} \times R_{d,t+k} \times v_{d,t} \quad (2)$$

We further assume that the expected capital appreciation rate $R_{d,t+k}$ is determined by district attributes, R_d , and common macro economic conditions from quarter t to quarter $t+k$, R_{t+k} .

$$R_{d,t+k} = R_d \times R_{t+k} \quad (3)$$

Combining equations (1) to (3), we have

$$\log(LP_{d,t}^i) = \beta \log(R_d) + \beta \log(PP_{d,t}) + \rho X_t^i + \beta \log(R_{t+k}) + \beta \log(v_{d,t}) + u_t^i. \quad (4)$$

We define a district dummy α_d that equals $\beta \log(R_d)$ plus the unconditional expectation of $\beta \log(R_{t+k}) + \beta \log(v_{d,t})$, and define a new error term ε_t^i that equals the remaining component of $\beta \log(R_{t+k}) + \beta \log(v_{d,t})$, which has a zero mean, plus u_t^i . Equation (4) becomes

$$\log(LP_{d,t}^i) = \alpha_d + \beta \log(PP_{d,t}) + \rho X_t^i + \varepsilon_t^i. \quad (5)$$

The coefficient β is expected to be positive if property prices help determine the demand for land and thus land prices.

To formally test the hypothesis that property prices have more explanatory power for land prices before 2004:3 than after, we add an additional explanatory variable, an interaction term $\beta_2 \log(PP_{d,t}) \times B_t$, to equation (5), where B_t is a dummy variable for quarters before 2004:3. Equation (5) becomes the following.

$$\log(LP_{d,t}^i) = \alpha_d + \beta_1 \log(PP_{d,t}) + \beta_2 \log(PP_{d,t}) \times B_t + \rho X_t^i + \varepsilon_t^i \quad (6)$$

It is clear that the interaction term $\log(PP_{d,t}) \times B_t$ captures the additional explanatory power of residential property prices before 2004:3. A positive and significant coefficient for the interaction term is consistent with the hypothesis.

It is important to discuss whether the coefficients of property prices and the interaction term in (6) capture the causation from property prices to land prices instead of the causation from land prices to property prices. Our data indicate that the median time from the start of construction to the presale of properties is 7 months. Assuming that developers start construction right after they acquire the land and they pre-sell the properties after 7 months, the prices developers are willing to pay for land is a function of the expected residential prices 7 months (three quarters) in the future. In other words, residential prices in a given month are determined by current demand for properties and land prices 7 months ago. This means property prices are a function of lagged land values instead of current land values. Therefore, it is plausible that coefficients of property prices and the interaction term capture the effect of property prices on current land prices instead of the effect of current land prices on current property prices.

In estimating the parameters of the model in (6), we use the log of land lease price per unit (10,000 RMB per square meter of lot size) as the dependent variable. To control for land characteristics that may affect the land lease price per unit, we first notice that land value may not be a linear function of parcel size and thus land price per unit is likely related to parcel size (see, e.g. Bao, Glascock, and Zhou, 2009, Colwell and Munneke, 1999, Lin and Evans, 2000, Tabuchi, 1996, Thorsnes, 2000, Thornes and McMillen, 1998, for evidence of concave or convex relationships between land values and parcel size). Though this paper does not intend to make novel contributions to understanding the relationship between land value and parcel size, we include the log of lot size (square meters) as an explanatory variable in equation (6) to control the relationship between land price per unit and parcel size.

Location is another important factor that affects land prices (see, e.g., Cervero and Duncan, 2004, Colwell and Munneke, 1999, Kau and Sirmans, 1979, Kowalski and Paraskevopoulos 1991, McMillen, 1990, 1996, Wang, 2009, among many others, for evidence), which is captured with the district dummy α_d in equation (6). The district dummy essentially captures all social and economic influences on land value (see, e.g.,

McMillen and McDonald, 2002, for evidence of the impact of such environment on land values) that remains constant in each district but vary across districts.

We also employ other control variables when estimating the parameters of equation (6). First, we include a dummy variable for mixed used land, as empirical evidence suggests that land use types (e.g., mixed use or residential uses) can claim a premium in land transactions (see, e.g., Brownstone and Devany, 1991, and Cervero and Duncan, 2004). Second, we include a density measure of the land, based on two alternative variables: (1) the density of the lot (the portion of the lot that will be occupied by the structure, in log) or (2) the ratio of the square meters of the planned structure to the square meters of the lot (in log). The reason is that land lots that allow higher density could be more valuable for developers (see, e.g. Peiser, 1987, for evidence of the effect of density on industrial land values). Finally, we include dummies for land traded via auctions and listings respectively, to control for a possible price impact of the transaction mechanisms.

This paper uses two different variables - the average and the median of *normalized* property prices - to measure property prices in each district and each quarter. This paper uses *normalized* property prices because they do not incorporate the influence of property attributes on property prices. Note that properties in our sample differ from each other in many ways. The observed differences include property type (single-family homes, townhouses, condos, and affordable condos), targeted buyers (domestic vs. foreign buyers), and home improvements (no improvement, basic improvement, bathroom/kitchen improvements, partial improvements, improvements on order, and complete improvements). It is plausible that different types of properties are priced differently. For example, holding other variables constant, single-family homes are likely to be more expensive than condos. Further, foreign and domestic buyers might have different preferences for property types and/or property characteristics and thus property prices vary across types of buyers. Finally, it is plausible that properties with more home improvements would be more expensive.

We normalize the prices of all residential communities in our sample so that each price provides a sample of the price for a standardized property. We define the standardized property as a condo without any improvements that target domestic buyers. We use the following property level regression for each city to normalize property prices.

$$P_t^i = \sum_{d=1}^D \beta_d \delta_d + \sum_{s=1}^T \rho_s T_s + \lambda F + \sum_{m=1}^M \gamma_m H_m + \xi_t^i \quad (7)$$

In the above equation, P_t^i is the average price (10,000 RMB per square meter, in log) in community i in quarter t . δ_d is the dummy for district d , which equals 1 if property i is located in district d and 0 otherwise. The number of districts, D , varies across cities. T_s is a dummy variable for s th type of properties. The property types captured by the dummies are single-family homes, townhouses, and affordable condos, but not all cities have all three types. F is a dummy variable for communities that target foreign buyers. H_m is a dummy variable for the m th type of home improvement. The home improvement types captured by the dummies are basic improvements, partial improvements, bathroom and kitchen improvements, optional improvements on order, and complete improvements. Apparently not all cities have all these improvement types. ξ_t^i is an error term that captures all other variables that affect the property price, including time variant variables such as mortgage interest rates and income level. Note that given the setting of the dummy variables, the “default” properties in equation (7) are the standardized property: condos that target domestic buyers and have no improvements.

Table 5 reports regression results for equation (7) for each of the seven cities. Reported statistics include the sample size, the number of districts in the city, and the name of the district that has the highest normalized property value (the highest coefficient of district dummy). A few things are worth noting. First, the regressions tend to fit the data well. The adjusted R square varies from 0.90 (Chongqing) to 0.45 (Shanghai), and is higher than 0.8 in four out of the seven cities. Second, the coefficients seem to make economic sense. For instance, the coefficient of single-family homes is always positive, and is statistically significant in five cities. This suggests that single-family homes are more expensive than condos (the default property type). The coefficient of affordable condos

is always negative (when this property type exists for a city), and is statistically significant in three out of five cities. Further, condos with complete improvements tend to be more expensive. All seem sensible.

Let P_t^{i*} be the normalized property value for properties in residential community i in quarter t ,

$$P_t^{i*} = P_t^i - \left(\sum_{s=1}^T \hat{\rho}_s T_s + \hat{\lambda} F + \sum_{m=1}^M \hat{\gamma}_m H_m \right), \quad (8)$$

where $\hat{\rho}_s$, $\hat{\lambda}$, and $\hat{\gamma}_m$ are estimated coefficients from equation (7). Note that P_t^{i*} corresponds to the standardized property artificially constructed from properties in community i in quarter t . P_t^{i*} captures unobserved value determinants that vary across both districts and time, but excludes value differences due to differences in property types, targeted buyers, and home improvements. After constructing P_t^{i*} , we calculate the average and the median of P_t^{i*} in each district and each quarter to serve as $PP_{d,t}$ in equation (6). Note that not all land transactions have corresponding $PP_{d,t}$, so the size of the sample used in actual regressions in equation (6) is smaller than the total sample size. Moreover, since not all land transactions have information on the ratio of the size of the planned structures to the lot size, the sample size is smaller when we include this density measurement as a control variable.

After constructing $PP_{d,t}$, we estimate equations (5) and (6) to test the hypothesis regarding the changing relationship between land and property prices before and after 2004:3. Table 6 reports the results of regressions that use the average of normalized property price for $PP_{d,t}$. Regressions I to III are based on equation (5), which does not include the interaction term between $PP_{d,t}$ and a dummy for quarters before 2004:3. Land prices are regressed on only $PP_{d,t}$ in regression I; on $PP_{d,t}$ and other control variables in regressions II and III. The difference between regression II and regression III is that regression II uses the portion of the lot that will be occupied by the structure to

measure lot density, while regression III uses the ratio of the size of the planned residential community (in square meters) to lot size (in square meters) to measure lot density. Regressions IV to VI are similar to regressions I to III except that they are based on equation (6) and thus include the interaction term between $PP_{d,t}$ and the dummy for quarters before 2004:3.

In estimating parameters, we use the within transformation of variables to take care of district dummies before estimating the coefficients. This means that we first subtract the district average across time from each variable and then estimate parameters using the demeaned variables. A demeaned variable is the deviation of this variable from its district average across time, and thus is not expected to be affected by time invariant location heterogeneity.

Table 6 provides two main results. First, the coefficient of the property price is significant and positive in all specifications, with and without the interaction term between the property price and the dummy variable for pre-2004:3 quarters being included in the regression. This is consistent with the notion that property prices have a significant effect on land prices over the entire sample period from 2001 to 2007. Second, once included, the coefficient of the interaction term between the property price and the dummy variable for pre-2004:3 quarters is positive and statistically significant at the 1% level. This indicates that residential property prices have significantly stronger explanatory power for land prices before 2004:3.

Coefficients for control variables also seem sensible in Table 6. First, the coefficient of lot size is negative and statistically significant whenever lot size is included in the regression. This is consistent with the evidence in Bao, Glascock, and Zhou (2009). Second, the coefficient of the dummy for mixed-used land is positive and statistically significant in the regressions. This indicates that mixed-used lots are more valuable than residential lots, probably because mixed-used lots can generate more cash flows. Third, the results indicate that lot density is positively related to land prices, which is also expected. Finally, the coefficients for the listing and auction dummy variables are both

positive and significant, and the coefficient of auction is larger, which appears to suggest that land lots traded via auction and listing tend to have higher prices.

To mitigate the effect of the reverse causation from land prices to property prices on results reported in 6, we re-produce Table 6 but substitute one-quarter lagged property prices for contemporaneous property prices. The results are presented in Table 7. Note that, in Table 7, the coefficient of the interaction term is positive and significant at the 1% level whenever the interaction term is included. This indicates that the key result in Table 6 - property prices have more explanatory power for land prices before 2004:3 - is robust. Further, being generally consistent with results in Table 6, the coefficient of property price is positive and significant, except in specifications IV and V.

Table 8 replicates the regressions in Table 6, but uses the median instead of the average of normalized property prices to measure property prices. It is important to note that the average of prices may be significantly affected by outliers; therefore, regressions using the median of prices constitute important robustness checks. The results in Table 8 are similar with the results in Table 6. Specifically, the coefficient of property prices is positive and statistically significant, which indicates that property prices help determine land prices both before and after 2004:3. Further, the coefficient of the interaction term between property prices and the dummy for quarters before 2004:3 is positive and significant whenever the interaction term is included. Therefore, the results are consistent with the hypothesis that the relationship between land and property prices is much stronger before 2004:3.¹⁰

It is important to analyze if the weaker relationship between land and property prices after 2004:3 is “temporary” or “permanent”. If the weaker relationship after 2004:3 is mainly due to the adjustment of the land market to a new equilibrium over a transition period, it would be difficult to argue that the new land trading system permanently reduces the efficiency of the land market. On the other hand, if the relationship between

¹⁰ We also replicate Table 7, replacing the lagged average normalized property prices with the lagged median normalized property prices. The results, which are not reported but are available from the authors, are consistent with those reported in Table 7.

land and property prices remains weak after the possible transition period, it seems fair to argue that the land market is permanently (or at least to the end of the sample period) less efficient after 2004:3.

Table 9 replicates the regressions in Table 6, but excludes all land transactions in a possible transition period of five quarters - from 2004:4 to 2005:4 to be specific. The two key results remain robust in this table. First, the coefficient of property prices is always positive and significant, which indicates that property prices help explain land prices both before and after 2004:3. Second, the coefficient of the interaction term is also always positive and significant whenever it is included. With a possible transition period being excluded, the results seem to indicate that the relationship between land and property prices is permanently weaker after 2004:3. While we believe that the five quarters from 2004:4 to 2005:4 might be long enough to cover the possible transition period, we analyze if the results are robust if we define longer transition periods and exclude them. Assuming that the transition period lasted for 11 quarters from 2004:4 to 2006:4, we find that the two key results are robust.¹¹

4. Conclusions

In August 2004, municipal governments in China established direct control of the land supply by requiring all buyers and sellers to go through a transparent tender/listing/auction process to purchase and sell land leases. This paper tests if this land supply regulation influences the efficiency of the residential land market by altering the relationship between residential land prices and residential property prices. Using a unique data set of detailed land and property transactions with manually collected district information for land lots, we analyze the relationship between land and property prices from the first quarter of 2001 to the fourth quarter of 2007. We find that the relationship is positive and significant both before and after 2004:3, but is much weaker after 2004:3. This result is robust to the choice of the measurement of property prices and the exclusion of a possible transition period. Under the reasonable assumption that property

¹¹ These results are available from the authors.

prices reflect the demand for properties both before and after 2004:3, results in this paper are consistent with the hypothesis that the Chinese urban residential land market is less efficient after local governments gained direct control on land supply, in the sense that land prices are less affected by property prices.

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References

Bao, Helen, Glascock, John and Sherry Zhefang Zhou, 2009, Land Value Determination in an Emerging Market: Empirical Evidence from China, University of Cambridge working paper.

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.

Cao, A. and R. Keivani, 2008, Land Markets, Property Led Growth and Urban Economic Development: Lessons from China, Oxford Brookes University Working Paper.

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

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.

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

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

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

Fu, Yu-Ming, 1996, Urban land in China's Economic Reform, *City Economist*, City University of Hong Kong.

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.

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.

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.

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

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

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

Muth, R. 1969, *Cities and Housing*, University of Chicago Press.

Muth, R, 1971, The Derived Demand for Urban Residential Land, *Urban Studies*, 8(3): 243-254.

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

Peterson, G.E., 2006, Land Leasing and Land Sale as an Infrastructure-financing Option, World Bank Policy Research Working Paper 4043, November.

Su, Fubing, 2008, Land market in China's modernization: regulations, challenges, and reforms, EIA (East Asia Institute) Background Brief No. 418, National University of Singapore <http://www.eai.nus.edu.sg/BB418.pdf>.

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

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.

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.

Wang, Rui, 2009, The Structure of Chinese Urban Land Prices: Estimates from Benchmark Land Price Data, *Journal of Real Estate Finance and Economics*, 39: 24-38.

Zheng, S. and M. Kahn, 2008, Land and Residential Property Markets in a Booming Economy: New Evidence from Beijing, *Journal of Urban Economics*, 63: 743-757.

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

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