

## What Drives Up Land Price in China? Evidence from Bidding Processes of Land Auctions in Beijing

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**Abstract** The land price in big cities draws much attention and discussion for its skyrocketing appreciation. Most researches are from the macro perspective due to data restriction. This paper aims to investigate the critical factors in the price formation process of a land auction, using the listing auction micro bidding-level data in Beijing from 2013 to 2018. We construct a model for the relationship between quitting price and land, bidder's characteristics, housing market conditions and competitive intensity (including private and public signals), then we use OLS for identification. We find that competitive intensity increases the quitting price by causing competition and interaction between bidders. More importantly, we find evidence of cheating behavior in the land market. Results show that bidders have higher quitting prices when they are in a joint venture, and when a central SOE developer or a top10 developer exist in the joint venture. We also find different behavior of developers in the short run and long run. Our research contributes to the literature of land auctions by analyzing the price formation process and developers' behavior. We also provide supporting evidence for the government to make adjustments of the auction system and identify the cheating developers.

**Keywords** land price formation; auction theory; joint venture; competitive intensity

### 1 Introduction

It has been extensively documented that the house price has been constantly and rapidly increasing for the last two decades in China, which raises concerns about potential bubble or other types of mispricing in the Chinese housing market<sup>[1, 2]</sup>. While in recently years, the land price draws even more attention and discussion for its skyrocketing appreciation, especially in big cities. The housing markets in third- or fourth-tier cities developed slowly and even shrunk in early 2013, causing many developers attempted to enter the housing markets of first- or

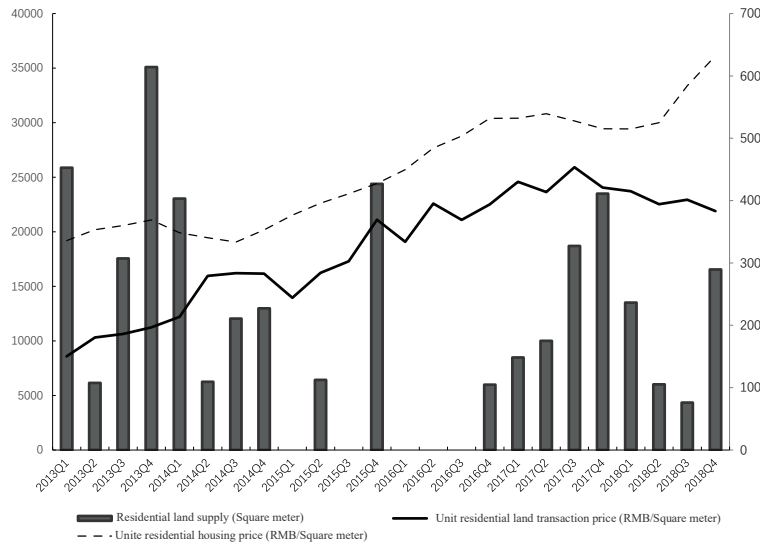
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second-tier cities, where house prices were earlier to recover in 2014. Thus, the competition in land markets of these big cities became more and more severe, and thus significantly boosted the land prices in the following years. As Figure 1 presents, the supply of residential land in Beijing was decreasing and volatile. From 2013Q1 to 2018Q4, residential housing price increased by 88.3% and residential land prices by 155.3%.



**Figure 1** Residential land supply and price, residential housing price from 2013Q1 to 2018Q4 in Beijing

This phenomenon attracts much attention of real estate researchers. Some literature has investigated potential reasons or mechanisms for the high and rapidly growing land price in China. Most of those studies are from a macro perspective, such as government behaviour<sup>[2, 3]</sup>, construction of railway<sup>[4]</sup>, price expectation and financial policies, and have derived extensive insightful conclusions. However, due to data restriction, very little has been known from a micro perspective. For example, auction is the only allowed land leasing form of profit-making land parcels in China, while the price formation in a land auction has been scarcely investigated.

This paper aims to investigate the critical factors in the price formation process of a land auction, using the listing auction micro bidding-level data in Beijing between 2013 to 2018. Compared with most land price researches using transaction price, the data advantage allows us to take a global approach to observing land price formation. We find that competitive intensity increases the quitting price by causing competition and interaction between bidders. More importantly, we find evidence of cheating behavior in the land market. Results show that bidders have higher quitting prices when they are in a joint venture, and when a central SOE developer or a top10 developer exist in the joint venture. We also find different behavior of developers in the short run and long run. Our research contributes to the literature of land auctions by analyzing the price formation process and developers' behavior. We also provide supporting evidence for the government to make adjustments of the auction system and identify the cheating developers. The remainder of this paper is organized as follows.

Relevant literature of land auction research is presented in Section 2. Then in Section 3 we introduce the background of land leasing in Beijing and construct the model. It is followed by Section 4 on data. After presenting empirical results in Section 5, Section 6 concludes.

## 2 Literature Review

### 2.1 The Transaction Price of Different Auction Forms and Private Negotiation

One of the focuses of land auction or real estate auction researches is to compare transaction prices between various auction forms and private negotiation<sup>[5–9]</sup>. Most of them find auctions have a premium over negotiation and other discount findings usually happen in markets that have high vacancy rate and search cost. The English (ascending) auction is found to generate higher average prices than second-price auction. The second-price auction generates higher average prices than the Dutch and first-price auction<sup>[10]</sup>. Auction prices for identical units are 13% higher than face-to-face bargaining by using a dataset of 83 condominium units held near Princeton<sup>[11]</sup>. Houses sold at English auction have an 8% price premium than negotiation by using a dataset of 243 houses sold in Melbourne from 1988 to 1989<sup>[12]</sup>. The first-price sealed-bid tender generates a lower land price, in the range of 1.2%~9.6% than the English auction<sup>[13]</sup>. The results validate the theoretical prediction that open auctions result in higher prices because bidders can infer other bidders' information by observing their bids in the common value auction paradigm. A model of disposition of real estate in a search market and an auction is proposed, and the research finds that buyers with high search costs will choose auctions and prices at auctions will be higher<sup>[14]</sup>. The average level of the parcel's actual tender prices from its estimated 'listing prices' is found to be negative, which suggests that prices in tender auctions (Zhaobiao) are lower than those in listing auctions (Guapai) in the Beijing land market<sup>[15]</sup>.

### 2.2 Price Formation in Auctions

Another focus is the price formation in the auction, in which characteristics of land, auction and bidder are widely discussed. These factors are usually controlled in recent studies<sup>[16, 17]</sup>. Characteristics of land include land-use type, land size, limitations of construction, transportation and so on. These factors are usually controlled in the hedonic model of nearly all previous literature<sup>[14, 18, 19]</sup>.

Characteristics of the auction include the bidder number and other structural features of the auction itself. A critical study examines the price formation process under small numbers competition using data of Singapore land auctions<sup>[18]</sup>. The first-price sealed-bid model shows that expected sales increase with the bidder number because each bidder has an incentive to offer a higher price and because of a greater likelihood that a high-value bidder is present. Bidder's experience and joint bidding are also considered but are not significant. Several papers follow the critical study and get similar results using data of Japanese and German<sup>[20, 21]</sup>. Considering common value, several studies explicitly argue that efficiency and the revenue generated will be higher when more bidders enter the auction<sup>[22, 23]</sup>. A bigger bidder number is found to increase the probability of an auction sale<sup>[24]</sup>. Probability of a subsequent post-auction transaction is significantly higher for apartments and terrace houses when the bidder number increases<sup>[25]</sup>. The paper shows that the number of bidders/bids is generally significant not only

in the probability of sale at auction but also in the premium of the sale price achieved. Bidder number is proved to positively impact the prices of residential properties that are unsuccessful at auction but sold subsequently<sup>[26]</sup>. Characteristics of bidder include bidder's experience, financial condition, joint venture and ownership, representing the bidder's heterogeneity. They have interacted relationship because ownership (like SOE in China) and joint venture can reveal information about bidder's experience and financial condition.

Experience of bidders will influence bidders' behavior in subsequent auctions<sup>[27]</sup>. Agents could possess comparative advantages from their past track records and established reputation<sup>[28]</sup>. An experimental setting is appealed to examine the bidding behavior of developers in repeated first-price sealed-bid auctions. The paper shows that repeated bidding does mitigate overbidding to some extent, which means bidders do learn over time and that experience matters<sup>[29]</sup>. Excess return is related positively to successful bidders' ability to create value from the development process. Experienced and government-linked developers seem to enjoy a competitive advantage when bidding for land<sup>[30]</sup>. The winner of a previous auction is more likely to participate in subsequent nearby land sales than the second-highest bidder of the same auction<sup>[16]</sup>. The study uses the accumulated gross floor area to represent the experience of developers.

Financial condition is a vital impactor of bidder's behavior and influences land price in auctions. Unconstrained bidders may bid more aggressively to increase the winning probability when opponents are financially constrained<sup>[31]</sup>. In comparison, constrained bidders are shown to behave optimally when bidding<sup>[32]</sup>. The event-study methodology is applied to Hong Kong land auctions and bidder number and financial condition like the bidder's liquidity are taken into account. The paper recognizes that financing difficulties and credit constraints can create entry barriers and curtail competition in land auctions. With constraints winners may pay less to obtain land at auction<sup>[33]</sup>. Qu and Liu finds that SOE land buyers are found to significantly drive up the auction premium (10%) relative to a private company land buyer<sup>[9]</sup>. Another important research argues that the ability to pay (capital resource or capital budget constraints) influences bid prices and final auction prices<sup>[34]</sup>. While high capital resource developers can choose to bid more to win, financial constraints imposed by firm-specific financial variables are conversely expected to restrict bids. The capital resource is represented by joint venture, if the bidder is a Hang Seng Index constituent and firm age. Financial constraint is represented by cash flow ratio, cash ratio, capital expenditure, debt capacity, etc. Bidding experience and bidder number in the auction are also controlled.

Joint venture is usually used to reduce development risk, and if the land parcel is large, joint venture is an excellent way to raise money. Joint venture is controlled in extensive literature regression, but few of them deeply discuss the relative phenomenon. How the stock market evaluates the outcome of open-bid English auctions when leasing rights to develop residential real estate projects in Hong Kong is examined. The study shows that joint bidding does not lead to increased bids based on pooled information but instead leads to reduced competition and decreased prices at auction<sup>[35]</sup>. A critical paper analyses firms' bidding behavior in the auctions for development land in Hong Kong<sup>[36]</sup>. The research shows that large real estate firms are more likely to be successful than top firms at auctions when bidding jointly, and joint bidding does not harm competition as reflected by the number of bids, bids per bidder and

number of bidders. Land prices also increase significantly in auctions won by joint bidders or alliances of large developers.

### 3 Background and Theoretical Analysis

#### 3.1 Land Auctions in Beijing

The land leasing reform in China started in late 1980s, during which the urban land supply gradually changed from administrative allocation to market-oriented methods, i.e., auctions. In 2001, China state council issued a notification named “Strengthening the Management of State-owned Land (SC [2001] No.15)”, which encouraged state-owned urban land use rights to be leased by tendering or auction. This notification aimed to improve the fairness of the land market, but it took limited practical effects on the land market at that time<sup>[15]</sup>. In 2004, A special notice (MLR [2004] No.71) was issued to enforce the execution of the aforementioned policy, requiring that state-owned urban land planned to be profit-making (including residential, commercial and office uses) should only be granted by public auctions in one of three specific forms, namely tender auction (Zhaobiao), oral auction (Paimai) and listing auction (Guapai). In 2006, another policy (SC [2006] No.31) was issued, which further extends the policy coverage to the land supply for industrial use. From then on, auction became the dominant land leasing method in China.

For each land auction, the local land bureau should issue a specific announcement at least 20 days before the auction date. The announcement typically specifies the auction date and place, and provides some basic information of the land parcel, such as its location, area and planning guidelines. The land bureau should also organize potential bidders to investigate the land parcel on site. The interested bidders submit their application along with some qualification certificates, and pay the bidding deposit. The bidders who pass the qualification review can finally enter the auction.

The oral auction principally follows the format of an ascending-bid auction (or English auction). All the qualified bidders would attend the auction at the announced date and place. Starting from a floor price, the bidders iteratively and ascendingly propose bidding prices. Finally, the highest bidder wins the auction and pay that price for the underlying land parcel. The tender auction is more similar to sealed-bid auctions. Each bidder independently submits the bidding documents, which is sealed so that no one knows her competitors. The land bureau would establish a special evaluation committee, and the committee gives a score for each bidder according to a comprehensive list of factors, including the bidding price, the bidder’s financial conditions and proposed development plan, etc. The bidder who get the highest score wins the land parcel. In other words, the bidder who offers the highest price may not always win<sup>[15]</sup>, which is different from a typical sealed-bid auction. The tender auction is typically used for projects involving public facilities.

The listing auction has one additional stage, namely listing stage, before the on-spot auction. The listing stage is typically online and anonymous, during which the bidders submit their quotations to the land bureau, and the land bureau updates the online bidding price list once confirmed the submissions. When the listing stage ends, the land parcel is sold to the bidder offering the highest price if the price equals or exceeds the reserve price; however, if more than

one bidders desire to further raise their quotations, the auction proceeds to the on-spot stage, which is almost identical to an oral auction. The listing auction is also called two-stage auction; the extra listing stage is designed for potential bidders to extensively investigate the land parcel, and thus avoid irrational bidding<sup>[37]</sup>.

In Beijing, the land bureau primarily adopts listing auction to lease land parcels. During the six years between 2013 and 2018 in Beijing, there were totally 687 land parcels leased, among which 605 (88%) were transacted by listing auction, 82 (12%) were by tender auction, while no parcel is by oral auction. In addition, listing auction plays an increasingly important role in Beijing's land market, since its adoption ratio increased from 79.4% in 2013 to 92.9% in 2018.

### 3.2 Theoretical Analysis

In this section, we provide simple theoretical analysis for the price formation in the on-spot stage (i.e., the second stage) of a listing auction. As aforementioned, the on-spot stage follows the procedure of an ascending-bid auction, in which the bidders iteratively and ascendingly call out their prices, until one follows the present highest price and the bidder offering that price wins. This procedure is often simplified as a English auction, in which the price continuously rises and the bidders gradually quit until only one bidder remains.

For each auction  $j$ , assume that bidder  $i$  has a value  $v_{ij}$  of the underlying land parcel. That means, bidder  $i$  would be indifferent between winning and not winning when the price equals  $v_{ij}$ . As a general specification,  $v_{ij}$  receives both private and public signals. The private signal is a function of factors including the land characteristics ( $LC$ ), housing market conditions ( $MC$ ) and the bidder's characteristics ( $BC$ ), etc.; it is formed and fixed before the auction starts. The public signal is a function of the competitors' behavior, more specifically, the timings when they quit bidding and the corresponding prices; it is represented by the competitive intensity ( $CI$ ) in literature<sup>[17, 18]</sup>.

Hence, the specification is:

$$\begin{aligned} v_{ij} &= f(\text{PrivateSignal}_{ij}, \text{PublicSignal}_j) \\ &= f(LC_j, MC_j, BC_i, CI_j). \end{aligned} \quad (1)$$

It is apparently a dominant strategy for the bidder  $i$  to stay in bidding until the price reaches  $v_{ij}$ . Hence, the bidder with the highest value will win the auction at the price equal to the value of the second-highest bidder. That is why the ascending auction is also referred as an open second-price auction. Formally, the final land price  $p_j$  is:

$$p_j = v_j^{(2)}, \quad (2)$$

where  $v_j^{(k)}$  denotes the  $k$ -th highest value among all bidders' values.

The above analysis suggests that the bidders' values of the land parcel is the key component to understand land price formation. However, most previous empirical studies use auction-level transaction data, modeling the transaction price as the dependent variable<sup>[15, 18]</sup>. In other words, their results yield from the winners' bidding prices (and corresponding independent variables) — a subset of the full sample, which causes sample selection issues and leads to

inconsistent estimation results. In this paper, we will use more micro bidding-level data, i.e., the bidding process records, to estimate and model all bidders' values. The results can provide more solid evidence for land price formation.

## 4 Data

### 4.1 Bidding Process and Quitting Price

Our core dataset is the on-spot bidding process records of all the listing land auctions in Beijing between 2013 and 2018. Each record includes the bidding price, the bidder's ID and the land ID. After data cleaning, there remains 416 listing auctions, with 244 bidders (all joint bidders are broken up into individual bidders for statistics) and 14097 bidding rounds (second stage). Among the 244 bidders, 64 are listed developers in Shanghai, Shenzhen or Hong Kong Stock Exchange.

As aforementioned, in an ascending auction, a bidder stays until the price reaches his value. The bidder will quit at that price, which is referred as quitting price. For each bidder, we can observe his last, or namely highest bidding price; and clearly his quitting price should at least exceed this last bidding price. In practice, we use the next bidding price (proposed by other bidders) as the estimate of the bidder's quitting price. Note that we cannot estimate the quitting price for the winner, which is consistent with the fact that the winner's value is theoretically unobservable in an ascending auction<sup>1</sup>.

The on-spot stage of a listing auction may include a special second phase, where the bidders are asked to compete by providing more social housing instead of offering higher land price. With some plausible assumptions, we can convert any given quantity of social housing provision to an equivalent bidding price. Thus, we can calculate the quitting price for the bidders who quits in the second phase. See Appendix 1 for more details.

The quitting price, which consistently measures the bidder's value of the underlying land, serves as the dependent variable in our specification. Given the control variables such as land characteristics, housing market conditions and the bidder's financial conditions, we particularly focus on three categories of variables that potentially drive up the land price, namely the bidder's historical land auction experience, the bidder's joint venture behavior and the competitive intensity of the auction.

### 4.2 Land Auction Experience

Bidders' short-term land auction experience may reveal vital clues about their eagerness for the land parcel and competitive willingness in the auction. Specifically, a real estate company has to maintain a minimum land stock for business operation in the housing market of a certain city<sup>[38]</sup>. Hence, if a developer failed in land auctions in the past months, especially in second places, he is probably very eager to win and thus tends to be more aggressive in bidding for the current land parcel. In contrast, if a developer won one or more land parcels in the past months, he is less restricted to acquire land stock to maintain operation, and probably has limited budget for a new parcel, thus tends to be more rational in bidding.

For each bidder and auction, we count his winning time and failure time in the second

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<sup>1</sup>The winner wins at the price equal to the second highest bidder's value.

place in the past six months, and use these two variables to represent the bidder's land auction experience.

### 4.3 Joint Venture

To cope with the severe competition, many developers choose to ally with other bidders, and participate in land auctions as joint ventures. This strategy will improve the developer's budget and competitiveness in the auction, and simultaneously reduce potential competitors, which both increase the possibility of winning the auction.

Developers are allowed to form joint ventures to participate in land auctions in China. Along with the rapidly rising land prices, joint venture becomes more and more popular in big cities, because a specific land parcel might be too expensive for a developer to afford independently. According to our dataset, there are 1602 participants in total during the six years for different auctions, in which joint bidders account for 25.1%. In terms of annual changes, from 2013 to 2018, joint bidders keep increasing from 13.6% in 2013 to 38.7% in 2018.

### 4.4 Competitive Intensity

The competitive intensity itself contributes to the land price appreciation. For a given land parcel, higher competitive intensity in the auction is likely associated with more bidding rounds and higher bidding prices; in other words, the bidders are more likely to propose prices positively biased from their values of the land, which are formed before the auction. We use two indicators to represent competitive intensity: Bidder number and bidding rounds per bidder. Definitions are shown in Table 1.

Table 1 presents the definition and descriptive statistics of the key variables of our dataset.

**Table 1** Definition and descriptive statistics of key variables

Variable	Definition	<i>N</i>	mean	sd
Bidder characteristics:				
<i>unit quitting price</i>	Adjusted quitting price per square meter of floor area using the first method; in RMB	1,664	20,889	11,987
<i>unit quitting price for robustness check</i>	Adjusted quitting price per square meter of floor area using the second method; in RMB	1,664	20,831	12,160
<i>joint size</i>	The participant number of the joint venture which the developer also participates in; equal to 1 if the developer is alone	1,664	1.708	1.038
<i>joint dummy</i>	The developer is joint venture or not; 1 = yes, 0 = no	1,664	0.417	0.493
<i>number of other local SOE in joint venture</i>	The number of other local SOE in joint venture which the developer participates in; equal to 0 if the ratio is 0 or the developer is alone	1,664	0.112	0.315
<i>number of other central SOE in joint venture</i>	The number of central SOE in the joint venture in which the developer participates; equal to 0 if the ratio is 0 or the developer is alone	1,664	0.174	0.459
<i>number of other top10 developers in the joint venture</i>	The number of other top10 developers in the joint venture which the developer participates in; equal to 0 if the ratio is 0 or the developer is alone	1,664	0.197	0.508



Table 1 (Continued)

Variable	Definition	N	mean	sd
<i>ratio of other local SOE in joint venture</i>	The ratio of other local SOE in joint venture which the developer participates in; equal to 0 if the ratio is 0 or the developer is alone	1,664	0.0404	0.120
<i>ratio of other central SOE in joint venture</i>	The ratio of other central SOE in the joint venture in which the developer participates; equal to 0 if the ratio is 0 or the developer is alone	1,664	0.0561	0.144
<i>ratio of other top10 developers in joint venture</i>	The ratio of other top10 developers in the joint venture which the developer participates in; equal to 0 if the ratio is 0 or the developer is alone	1,664	0.0656	0.160
<i>winner time last six months</i>	The time that the developer won land auctions last six months	1,664	1.044	1.361
<i>second time last six months</i>	The time that the developer failed with second-highest price last six months	1,664	1.058	1.698
<i>local SOE</i>	The developer is local state-owned enterprise or not; 1 = yes, 0 = no	1,664	0.146	0.353
<i>central SOE</i>	The developer is central state-owned enterprise or not; 1 = yes, 0 = no	1,664	0.148	0.356
<i>top10</i>	The bidder is top10 developer or not, top 10 is defined by the value of sales in 2018; 1 = yes, 0 = no	1,664	0.650	0.477
<i>listed</i>	The bidder is listed in Shanghai, Shenzhen or Hong Kong Stock Exchange or not; 1 = yes, 0 = no	1,664	0.218	0.413
<i>asset</i>	Total asset value of the developer last year; in ten billion RMB	1,082	17.48	18.76
<i>roe</i>	Return on net equity rate of the developer last year; in 1/100000	1,081	0.0265	0.120
<i>Auction characteristics:</i>				
<i>Bidder number</i>	Number of bidder submits quotation in the second stage	1,664	6.748	2.753
<i>first bidding round</i>	Number of bidding round in the first stage	1,664	9.169	3.967
<i>second bidding round</i>	Number of bidding round in the second stage	1,664	55.53	34.75
<i>second stage presenece</i>	Number of bidder present in the second stage	1,664	8.954	3.986
<i>bidding rounds per bidder</i>	Second bidding round divided by bidder number	1,664	0.879	0.567
<i>never-win bidder number</i>	Number of bidders that never win from 2013 to 2018 in the auction but submit a quotation in the second stage	1,664	0.605	0.978
<i>ever-win bidder number</i>	Number of bidders that ever win from 2013 to 2018 in the auction and submit a quotation in the second stage	1,664	6.144	2.477
<i>if never-win bidder exists</i>	If a never-win bidder exists in the auction; equals to 1 if exists	1,664	0.387	0.487
<i>if ever-win</i>	If the bidder win at least one time during the sample period	1664	0.909	0.286

**Table 1** (Continued)

Variable	Definition	<i>N</i>	mean	sd
<i>if secret joint type 1 exists</i>	If a secret joint composed of ever-win bidder and never-win bidder appearing in the same auction for more than five times exists in the auction; equals to 1 if exists	1,664	0.0325	0.177
<i>if secret joint type 2 exists</i>	If a secret joint composed of ever-win bidder and never-win bidder appearing in the same auction for more than three times exists in the auction; equals to 1 if exists	1,664	0.224	0.417
Land characteristics:				
<i>distance to city center</i>	Distance to the city center; in meters	1,664	25,214	14,815
<i>distance to subway station</i>	Distance to the nearest subway station; in meters	1,664	5,076	9,637
<i>floor area</i>	The total floor area; in square meters	1,664	137,889	67,303
<i>far</i>	Ratio of the floor area to the land area	1,664	2.193	0.834
<i>residential use</i>	The land parcel is for residential use or not; 1 = yes, 0 = no	1,664	0.843	0.364
<i>commercial use</i>	The land parcel is for commercial use or not; 1 = yes, 0 = no	1,664	0.727	0.446
<i>both residential and commercial use</i>	The land parcel is for both residential and commercial use or not; 1 = yes, 0 = no	1,664	0.585	0.493

## 5 Empirical Results

According to Equation (1), we formulate our empirical specification as:

$$\begin{aligned} \log(\text{QuittingPrice}_{ij}) &\approx \log(v_{ij}) \\ &= \alpha \cdot LC_j + \beta \cdot MC_j + \gamma \cdot BC_i + \theta \cdot CI_j + \varepsilon_{ij}, \end{aligned} \quad (3)$$

where quitting price measures the bidder's value of the land parcel. More specifically, land characteristics (*LC*) include planning requirements, geographic proximities and district dummies; housing market conditions (*MC*) are represented by year and district dummies; the bidder's characteristics (*BC*) include his financial conditions, land auction experience and joint venture behavior, etc. Competitive intensity (*CI*) is represented by bidder number and bidding rounds per bidder.

In this paper, we use bidding-level data to directly estimate each bidder's value of the auctioned land. Compared with those by auction-level data, our empirical results provide more consistent and straightforward evidence for land price formation.

### 5.1 Baseline Results

Table 2 presents our baseline empirical results. Column (1) additionally incorporate a dummy indicating whether the bidder is in a joint venture, and column (2) replace it with the joint venture size. The estimation results are consistent. Participating in a joint venture will averagely increase the bidder's quitting price by 5.95%; or a 10% increase in the joint size is associated with 1% increase in the quitting price. The effects are significant at 1% statistical

**Table 2** Baseline results

Variable	(1)	(2)	(3)	(4)	(5)
		log( <i>unit quitting price</i> )			log( <i>unit transaction price</i> )
<i>joint dummy</i>	0.0595*** (3.248)				
log( <i>joint size</i> +1)		0.100*** (3.548)	0.0795*** (2.719)	0.0807*** (2.796)	0.205*** (4.082)
log( <i>winner time last six months</i> +1)			0.0182 (0.988)	0.0145 (0.792)	−0.0545 (−1.582)
log( <i>second time last six months</i> +1)			0.0440*** (2.763)	0.0456*** (2.914)	0.0695** (2.468)
log( <i>bidder number</i> +1)				0.193*** (6.617)	0.349*** (7.421)
<i>bidding rounds per bidder</i>				0.0501** (2.492)	0.0176*** (5.551)
<i>local SOE</i>	−0.000826 (−0.0308)	0.000415 (0.0156)	−0.0196 (−0.716)	−0.0199 (−0.735)	−0.0272 (−0.528)
<i>central SOE</i>	0.0573** (2.292)	0.0558** (2.229)	0.0503** (1.992)	0.0340 (1.336)	0.0355 (0.748)
<i>listed</i>	0.0808*** (3.787)	0.0802*** (3.760)	0.0798*** (3.749)	0.0850*** (3.878)	0.0896** (2.127)
<i>top10</i>	0.00995 (0.420)	0.0103 (0.435)	−0.00727 (−0.301)	0.0171 (0.696)	−0.0471 (−1.042)
log( <i>asset</i> )					−0.484*** (−11.28)
<i>roe</i>					−0.0590*** (−5.419)
log( <i>distance to city center</i> )	−0.576*** (−15.66)	−0.576*** (−15.67)	−0.573*** (−15.62)	−0.531*** (−13.43)	−0.404*** (−5.339)
log( <i>distance to subway station</i> )	−0.0637*** (−6.352)	−0.0638*** (−6.333)	−0.0637*** (−6.357)	−0.0545*** (−5.407)	−0.0354** (−2.043)
log( <i>floor area</i> )	0.0260 (1.381)	0.0245 (1.301)	0.0214 (1.131)	0.0335* (1.701)	−0.0756** (−2.030)
<i>far</i>	−0.0512*** (−2.857)	−0.0496*** (−2.777)	−0.0513*** (−2.868)	−0.0453** (−2.183)	0.0118 (0.474)
<i>commercial use</i>	−0.216*** (−6.263)	−0.221*** (−6.433)	−0.222*** (−6.440)	−0.207*** (−5.425)	−0.251*** (−3.992)
<i>both residential and commercial use</i>	0.185*** (5.830)	0.190*** (6.001)	0.187*** (5.921)	0.176*** (5.182)	0.268*** (5.201)
district fixed effect	yes	yes	yes	yes	yes
year fixed effect	yes	yes	yes	yes	yes
observations	1,664	1,664	1,664	1,551	433
$R^2$	0.730	0.730	0.732	0.723	0.769

level. As aforementioned, the total cost of a land parcel in Beijing is too high to afford for most developers, and forming a joint venture allows themselves to share budget with their allies. In the same time, each member in the joint venture takes less risk than he would take as an independent bidder. Hence, the developers would be more risk-seeking and bid more aggressively if they are in a (larger) joint venture.

In column (3), we regress the quitting price on bidder’s land auction experience variables, with extensive control variables. The results suggest that the second-place failure experience in land auctions in the past half year significantly increases the bidder’s quitting price. According to the estimated coefficient, a 10% increase in the second-place failure times is associated with 0.44% increase in the quitting price. However, the winning experience has insignificant effect on the bidder’s quitting price. These results are as expected. Being the second place in previous land auctions suggests that the bidder has both capacity and willingness to buy land parcels, and the failure indicates that the bidder still has sufficient budget for the current parcel. It is plausible for such bidders to be aggressive in bidding. In such a competitive market as Beijing with limited land supply, most developers have to fight for at least one land parcel to maintain the basic business operation in this city. As an extreme case, “surviving in Beijing” could be a part of the enterprise strategy, and the bidder would be insensitive to the cost for buying the land parcel.

Column (4) focuses on the competition intensity of the auction. The results show that both *bidder number* and *bidding rounds per bidder* have significantly positive effect on the bidder’s quitting price. With all other variables controlled, a 10% increase in the *bidder number* corresponds to 1.93% increase in the quitting price; and a standard deviation increase in the *bidding rounds per bidder* corresponds to 5.01% increase in the quitting price. These results suggest that the bidders do perceive and positively respond to public signals. The bidders do not stick to the private values which are formed based on their private signals before the auction, but probably alter their values according to the on-spot competitive intensity. This may imply the existence of irrational bidding in Beijing’s land auctions.

We conduct extensive robustness checks to verify the above findings. Specifically, we adjust the time window (as three months, nine months and one year) for counting the winning and second-place times as land auction experience; we use alternative measures for competitive intensity; and we use alternative method to calculate the equivalent land price. Most results remain robust. The details can be found in Appendix 2.

The estimated coefficients on control variables are also mostly as expected. For example, the land value is positively related to better geographic proximities (closer to city center or subway station), while negatively related to disadvantages in planning requirements (e.g., high residential density). Lands for both residential and commercial use are more valuable. These results are consistent with previous literature using typical housing hedonic models<sup>[17, 34, 39]</sup>. Central SOE developers are significantly and positively associated with higher quitting prices, while local SOE developers are not. In China, central SOEs are regarded to have more abundant financial resources with lower cost, which may reduce their sensitivity to land price in auctions. In column (4) we find that listed bidders have an 8.5% higher quitting price than others on average, which is consistent with previous studies<sup>[19, 34]</sup>. In addition, the coefficients on typical

financial indicators (asset and ROE) are all insignificant.

To compare with previous studies using auction-level data, we re-estimate the specification in column (4) with winners' data and transaction prices. The results are reported in column (5). In general, the coefficient signs on most dependent variables remain unchanged, while the coefficient magnitudes are substantially different. For example, the coefficients on the bidder's asset and ROE become statistically significant. We believe that the results in column (5) are biased by the sample selection issue. Note that the coefficient on bidder number in column (5) is twice larger than that in column (4). Theoretically, the transaction price increases with the bidder number because (i) each bidder tends to offer higher price in response to the higher competitive intensity; (ii) there is a higher likelihood that a higher-value bidder is present<sup>[18]</sup>. The two mechanisms are mixed and confounded with each other in column (5), while we can clearly identify the effect of the first mechanism separately from the second one in column (4) using bidding-level data. Hence, we can confidently conclude that the bidder's value is positively affected by public signals.

## 5.2 Heterogeneity Analysis: Joint Venture

Participating in a joint venture will increase the bidder's value of the land parcel. In this section, we will investigate whether specific characteristics of the allies can further amplify the effect.

Table 3 presents the heterogeneity analysis for different types of joint venture. We add *number of other local SOE in joint venture* and *number of other central SOE in joint venture*. The latter is significant in column (1). We change the indicator to corresponding ratio in column (2). The coefficient of central SOE variables are significant, which means that other companies in the joint venture are more impacted by central SOEs, so they bid more than bidding alone and bidding in a joint venture with less central SOEs.

We also do a similar analysis for the number and ratio of top10 developers in column (3) and (4). We find that a joint venture that contains a high ratio of central SOEs and top10-developers tends to bid more, the reason is the mutual influence of bidders within the joint venture.

## 5.3 Heterogeneity Analysis: Competitive Intensity

Higher-competitive developers may contribute more competitive intensity than lower-competitive ones. In this section, we investigate which kind of bidders are the main source of competitive intensity.

According to the model, the *bidder number* is a symbol of public information and interaction between bidders. We are curious about if different types of bidders in the auction can convey different public information and lead to different interaction between bidders. We find that several bidders never win from 2013 to 2018. Naturally, we wonder whether other bidders will see them as valid bidders (by counting them into the bidder number when making a decision). The bidders who never win may not have an impact on other's quitting price for the lack of competitiveness. The results are presented in Table 4. It is found that both *ever-win bidder number* and *never-win bidder number* variables have an impact on the quitting price, but the impact direction is different. Column (1) and (2) indicate that the appearance of the never-win

bidders will significantly decrease the quitting price of bidders in the auction. There are three possible influence channels and we write them as hypotheses:

**H1** Never-win bidders are relatively weak in financial condition and operating ability. The appearance of such bidders gives others a public signal that the land is worthless and affects the common value, thus leads to a lower quitting price.

**H2** Never-win bidders may be called by some large companies to ‘price up’. This behavior means that large companies may have a strong incentive to obtain this land, so other bidders understand that there is not much hope for winning, thus simply quit early.

**Table 3** Heterogeneity analysis: Joint venture

Variable	(1)	(2)	(3)	(4)
	log( <i>unit quitting price</i> )			
log( <i>joint size</i> +1)	0.00430 (0.117)	0.0221 (0.666)	0.00343 (0.1000)	0.0156 (0.488)
log( <i>number of other local SOE in joint venture</i> +1)	0.0478 (1.086)			
log( <i>number of other central SOE in joint venture</i> +1)	0.122*** (3.531)			
<i>ratio of other local SOE in joint venture</i>		0.0651 (0.846)		
<i>ratio of other central SOE in joint venture</i>		0.238*** (3.992)		
log( <i>number of other top10 developers in the joint venture</i> +1)			0.142*** (4.389)	
<i>ratio of other top10 developers in the joint venture</i>				0.274*** (4.814)
log( <i>winner time last six months</i> +1)	0.0110 (0.599)	0.00898 (0.491)	0.0114 (0.628)	0.00894 (0.492)
log( <i>second time last six months</i> +1)	0.0456*** (2.929)	0.0458*** (2.938)	0.0376** (2.399)	0.0365** (2.323)
log( <i>bidder number</i> +1)	0.188*** (6.422)	0.190*** (6.524)	0.194*** (6.668)	0.195*** (6.706)
<i>bidding rounds per bidder</i>	0.0486** (2.416)	0.0480** (2.383)	0.0536*** (2.675)	0.0530*** (2.645)
land characteristics	yes	yes	yes	yes
bidder characteristics	yes	yes	yes	yes
year and district dummies	yes	yes	yes	yes
observations	1,551	1,551	1,551	1,551
$R^2$	0.725	0.725	0.726	0.727

**Table 4** Heterogeneity analysis: Competitive intensity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable	log( <i>unit quitting price</i> )						
log( <i>joint size</i> +1)	0.0627** (2.190)	0.0643** (2.245)	0.0831*** (2.784)	0.0847*** (2.828)	0.0610** (2.121)	0.0885*** (2.962)	0.0879*** (2.950)
log( <i>winner time</i> )	0.0172	0.0171	0.0216	0.0207	0.0231	0.0237	0.0226
last six months+1)	(0.944)	(0.941)	(1.162)	(1.109)	(1.250)	(1.271)	(1.219)
log( <i>second time</i> )	0.0393**	0.0407***	0.0403**	0.0416***	0.0405***	0.0384**	0.0418***
last six months+1)	(2.522)	(2.610)	(2.551)	(2.628)	(2.597)	(2.434)	(2.651)
log( <i>ever-win bidder</i> number+1)	0.241*** (8.799)	0.244*** (8.893)	0.267*** (9.171)	0.268*** (9.201)	0.247*** (9.044)	0.270*** (9.259)	0.273*** (9.293)
log( <i>never-win bidder</i> number+1)	−0.104*** (−4.510)		−0.123*** (−4.941)		−0.116*** (−4.907)	−0.107*** (−4.047)	−0.0772*** (−2.626)
<i>bidding rounds</i>	0.0435**	0.0433**	0.0481**	0.0477**	0.0434**	0.0499**	0.0504**
<i>per bidder</i>	(2.275)	(2.230)	(2.396)	(2.346)	(2.272)	(2.477)	(2.535)
<i>if ever win</i>					−0.0577* (−1.671)		
<i>if never-win bidder exists</i>		−0.0806*** (−4.101)		−0.0949*** (−4.656)			
<i>if secret joint type 1 exists</i>						−0.125*** (−2.661)	
<i>if secret joint type 2 exists</i>							−0.0752*** (−2.751)
land characteristics	yes	yes	yes	yes	yes	yes	yes
bidder characteristics	yes	yes	yes	yes	yes	yes	yes
year and district dummies	yes	yes	yes	yes	yes	yes	yes
observations	1,551	1,551	1,430	1,430	1,551	1,430	1,430
$R^2$	0.731	0.731	0.733	0.732	0.732	0.734	0.734

**H3** The negative effect is caused by the low quitting price of never-win bidders themselves.

Firstly, we check the third channel by removing the never-win bidders' samples out of our data. Coefficients reported in column (3) and (4) change obviously especially the coefficient of *never-win bidder number* is smaller, which suggests never-win bidders possibly bid more. We check it by adding *if ever win* in column (1)'s model and get column (5). Coefficients reported in column (5) change obviously, which suggest that never-win bidders themselves actually bid more in the auction. This result rejects H3. The coefficient of *never-win bidder number* turns smaller, we have two possible explanations. Firstly, it is reasonable that never-win bidders

desire more than ever-win bidders, so they bid more in the auction. Secondly, according to H2, never-win bidders are called to ‘price up’, so they bid more.

As for the second channel H2, we do further research to find the secret joint venture composed of ever-win bidders and never-win bidders. We count the number of auctions where two kinds of bidders simultaneously come. There are 792 compositions of one ever-win bidder and one never-win bidder in the same auction, but only 1 (0.13%) of them appear seven times, and only 42 (5.3%) of them appear at least three times. It is a strong signal for secret joint venture which suggests that there is cheating behavior or even cartel in the market, that’s why English auction is seldom used in some countries<sup>[40, 41]</sup>. If we see the bidder pairs appearing seven times and the bidder pairs appearing at least three times as two types of secret joint venture, then develop dummies to indicate if a secret joint venture exists in the auction based on column (3), we get column (6) and (7). The results show that the dummy is significant and the coefficient of never-win bidder number is larger. The coefficients tell us that H1 and H2 are equally important channels, which means that secret joint venture can cause others bid less than about 10%, and 10% increase in never-win bidder number corresponds to about 1% decrease in others’ quitting price. The above analysis shows that the government needs to strengthen controls to avoid fraud/cheating behaviors in land auctions.

In China, small businesses that participate in fraudulent land auctions along with large businesses are generally known as “Majia”. The government has developed relevant measures to impose restrictions. For example, many land parcels to be launched in 2023 have supplementary announcements requiring that “the same enterprise and its controlled companies shall not participate in the bidding for the same parcel of land”, or “Member companies of the same group are not allowed to sign up to bid for the same land at the same time”. For enterprises that violate the regulations, their qualifications to participate in the land auction will be cancelled and their bids will be invalidated. The overall regulatory trend is to increase the focus on fraud that occurs between companies with obvious economic ties. Based on the research of this article, joint fraud will also occur between companies with no obvious economic ties. This needs to be determined based on historical data using a data set similar to this article, and more accurate supervision can be carried out.

## 6 Conclusion

There are extensive empirical studies of price formation during a land auction, but the research of mainland China is rare. This paper discusses how auction, land and bidder characteristics affect the land price, where we use the quitting price of each bidder. We find that competition intensity affects the common value part of the quitting price, ever-win bidder number and never-win bidder number have different impacts on quitting price. When the never-win bidder number rises in the auction, quitting price of other bidders decreases mainly through two channels: low price public signal and secret joint venture public signal. We also find that joint bidders have higher quitting prices, and when a central SOE or a top10 developer in the joint venture, the price will increase further. Moreover, in the long run, experienced developers will bid more, and developers tend to maintain a specific land stock in the short run. The boundary of short and long may be between six months and one year. This paper makes contributions to



price formation and bidder's behavior in the auction of China's land market, it also provides supporting evidence for government regulation to curb excessive land price rise. Competition intensity and joint bidding behavior in the auction should be controlled, and the government must be aware of the secret joint venture and even cartel in the market. What needs to be emphasized is that due to the logic of "city-specific policies" in formulating policies, China's real estate and land policies are heterogeneous to a considerable extent in different cities. In the future, further research needs to be done on the basis of obtaining similar data sets in different cities.

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## Appendix 1 Equivalent Price for Social Housing

The on-spot stage of a listing auction could be further divided into two phases. The first phase is a common scenario where the bidders compete by proposing higher prices, until the price reaches a ceiling prescribed in the auction announcement; and then the auction proceeds to the second phase, where the bidders are asked to compete by providing more social housing either inside the land site being auctioned, or somewhere else. These social housing units will be sold to the local government or the public at a given and relatively low price, or directly transferred to the local government for free. The building site, requirements, selling price and time of the social housing are also given in the auction announcement in most cases.

We provide simple method to calculate the equivalent land price. Specifically, we regard that the underlying price “raises” are continuous from first to second phase, and thus assume that the “raises” of the last call-out in the first phase is equal to the “raises” of the first call-out in the second phase. Formerly, denote the last price raise in the first phase as  $\Delta p_L^{(-1)}$ , and the first social housing quantity raise in the second phase as  $\Delta s_{SH}^{(1)}$ . The equivalent price  $p_L^*$  is:

$$p_L^* = \tilde{p}_L + \frac{s_{SH}}{\Delta s_{SH}^{(1)}} \cdot \Delta p_L^{(-1)}. \quad (4)$$

We also provide an alternative method to calculate the equivalent land price, which is used for robustness checks. Given a land price, providing more social housing units means less common residential housing units (if the social housing is built inside the auctioned land), or additional construction cost (if the social housing is built outside), both of which will reduce the project profit; so it could be equivalent for the bidder to offering a higher price without social housing. Formerly, denote the floor area of the land, common residential housing and social housing as  $s_L$ ,  $s_{RH}$  and  $s_{SH}$ , their (expected) unit price as  $p_L$ ,  $p_{RH}$  and  $p_{SH}$ , (estimated) construction cost as  $c_{RH}$  and  $c_{SH}$ ; for any given social housing quantity  $s_{SH}$ , there exists an equivalent price  $p_L^*$  above the price ceiling  $\tilde{p}_L$ , and it is indifferent for the bidder between offering (i) a land price equal to  $\tilde{p}_L$  plus social housing of quantity  $s_{SH}$ , and (ii) the equivalent land price  $p_L^*$  plus no social housing.

Hence,

$$\begin{aligned} \text{Profit} &= (p_{RH} - c_{RH}) \cdot s_L - p_L^* \cdot s_L \\ &= \begin{cases} (p_{RH} - c_{RH}) \cdot (s_L - s_{SH}) + (p_{SH} - c_{SH}) \cdot s_{SH} - \tilde{p}_L \cdot s_L, & \text{if inside,} \\ (p_{RH} - c_{RH}) \cdot s_L + (p_{SH} - c_{SH}) \cdot s_{SH} - \tilde{p}_L \cdot s_L, & \text{if outside.} \end{cases} \end{aligned} \quad (5)$$

Solve  $p_L^*$  from the Equation:

$$p_L^* = \begin{cases} \tilde{p}_L + \frac{s_{SH}}{s} (p_{RH} - c_{RH} - p_{SH} + c_{SH}), & \text{if inside,} \\ \tilde{p}_L + \frac{s_{SH}}{s} (-p_{SH} + c_{SH}), & \text{if outside.} \end{cases} \quad (6)$$

Among the 416 listing auctions in our dataset, 119 (28.6%) enter the second phase in the on-spot stage. Among them exist six specific types of social housing: Public Rental Housing (inside), Affordable Housing (outside), Price Limited Housing (inside), Hospital Housing (outside), Developer-Holding Housing (inside), Non-investment housing (inside). We collect (or estimate) their unit selling price and construction cost case by case. Thus, we can convert all the bidding records in the second phase to the equivalent bidding prices.

After the above calculations, we get two variables *unit quitting price* and *unit quitting price for robustness check*.

## Appendix 2 Robustness Checks

Auction experience:

We also add other indicators of bidder's experience and it can also be seen as a robustness check. As for the experience, Table 5 column (1) to (3) shows that the winner and second time in different periods have different meanings. The coefficient of *second time last three months* is positive significant at 1% level, which are similar to *second time last six months* and can be explained by the bidders' behavior of keeping a land stock. Auction history in last one year is different, for the coefficient of *winner time last one year* is positively significant. This is a phenomenon involving the business cycle of an enterprise. In the short term, the extent if the bidder is experienced is set, so to keep a specific land stock can explain the bidder's behavior. In the long term, experienced bidders bid more for their better operating ability and risk control ability, which is represented by *winner time last one year*.

Competitive intensity:

Except for *bidding rounds per bidder*, we only use number of bidder submits quotation in the second stage to represent bidder number and do not include *first bidding round and second stage presence* in the model. The reason is that in the first stage most of the bidders only bid once to express the desire to enter the second stage, and few of the bidders present in the second stage do not submit a bid. So the three number indicators are similar and we do not need to control them simultaneously. Table 5 column (4) to (6) repeats the baseline model using the three indicators. We can also find that the coefficient of *bidder number* is the biggest and keeps significant when adding three indicators into model, which means number of bidder submits quotation in the second stage has a more significant impact on quitting price. Finally, we use it to represent bidder number in the baseline model.

Quitting price:

We also conduct a robustness check about *unit quitting price for robustness check*. Using it and estimate the same model in Table 2 column (1) to (4), results are shown in Table 6, which suggests two ways of calculating prices have little difference. Actually results using *unit quitting price for robustness check* of all the models in this paper are similar to these using *unit psychological price*, so the adjustment method is robust.

**Table 5** Robustness check of different indicators of auction experience and competitive intensity

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	log(unit quitting price)					
log( <i>joint size</i> +1)	0.0804*** (2.812)	0.0970*** (3.351)	0.0787*** (2.714)	0.0805*** (2.792)	0.0805*** (2.782)	0.0804*** (2.789)
log( <i>winner time last three months</i> +1)	0.0388* (1.946)					
log( <i>second time last three months</i> +1)	0.0572*** (3.066)					
log( <i>winner time last six months</i> +1)				0.0114 (0.618)	0.0149 (0.812)	0.0150 (0.816)
log( <i>second time last six months</i> +1)				0.0448*** (2.805)	0.0439*** (2.776)	0.0431*** (2.716)
log( <i>winner time last nine months</i> +1)		0.0266 (1.454)				
log( <i>second time last nine months</i> +1)		0.0253 (1.566)				
log( <i>winner time last one year</i> +1)			0.0372** (2.111)			
log( <i>second time last one year</i> +1)			0.0246 (1.454)			
log( <i>first bidding round</i> +1)				-0.0468 (-0.554)	-0.0492 (-1.076)	-0.112 (-1.300)
log( <i>second stage presence</i> +1)				0.182** (2.181)		0.0753 (0.900)
log( <i>bidder number</i> +1)	0.192*** (6.759)	0.164*** (5.207)	0.150*** (4.630)		0.236*** (4.799)	0.222*** (4.499)
<i>bidding rounds per bidder</i>	0.0484** (2.465)	0.0461** (2.203)	0.0438** (2.039)	0.0422** (2.050)	0.0490** (2.434)	0.0481** (2.375)
land characteristics	yes	yes	yes	yes	yes	yes
bidder characteristics	yes	yes	yes	yes	yes	yes
year and district dummies	yes	yes	yes	yes	yes	yes
observations	1,597	1,419	1,305	1,551	1,551	1,551
$R^2$	0.728	0.720	0.700	0.720	0.723	0.723

**Table 6** Robustness check of price adjustment method

Variable	(1)	(2)	(3)	(4)
	log(unit quitting price for robustness check)			
<i>joint dummy</i>	0.0457** (2.490)			
log( <i>joint size</i> +1)		0.0875*** (3.094)	0.0680** (2.322)	0.0666** (2.298)
log( <i>winner time last six months</i> +1)			0.0170 (0.904)	0.0146 (0.785)
log( <i>second time last six months</i> +1)			0.0411** (2.537)	0.0436*** (2.740)
log( <i>bidder number</i> +1)				0.190*** (6.322)
<i>bidding rounds per bidder</i>				0.0555*** (2.682)
<i>local SOE</i>	-0.00364 (-0.131)	-0.00337 (-0.122)	-0.0220 (-0.783)	-0.0203 (-0.727)
<i>central SOE</i>	0.0498** (1.981)	0.0475* (1.893)	0.0425* (1.678)	0.0272 (1.061)
<i>listed</i>	0.0913*** (4.126)	0.0909*** (4.112)	0.0905*** (4.098)	0.0954*** (4.164)
<i>top10</i>	0.00529 (0.222)	0.00527 (0.221)	-0.0111 (-0.459)	0.0135 (0.547)
log( <i>distance to city center</i> )	-0.540*** (-13.75)	-0.540*** (-13.78)	-0.537*** (-13.74)	-0.506*** (-11.89)
log( <i>distance to subway station</i> )	-0.0685*** (-6.601)	-0.0686*** (-6.591)	-0.0685*** (-6.610)	-0.0599*** (-5.744)
log( <i>floor area</i> )	0.0160 (0.794)	0.0139 (0.689)	0.0110 (0.540)	0.0268 (1.251)
<i>far</i>	-0.0454** (-2.544)	-0.0436** (-2.454)	-0.0452** (-2.541)	-0.0402* (-1.940)
<i>commercial use</i>	-0.214*** (-6.083)	-0.218*** (-6.227)	-0.219*** (-6.224)	-0.193*** (-4.994)
<i>both residential and commercial use</i>	0.193*** (5.946)	0.197*** (6.092)	0.195*** (6.014)	0.179*** (5.127)
district fixed effect	yes	yes	yes	yes
year fixed effect	yes	yes	yes	yes
observations	1,664	1,664	1,664	1,551
$R^2$	0.708	0.709	0.711	0.704