# China's Land Market Auctions: Evidence of Corruption?

*by*
*Hongbin Cai*[♣]
*Vernon Henderson*[♦]
*Qinghua Zhang*[♥]

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Abstract

This paper studies the urban land market in China in 2003—2007. In China, all urban land is owned by the state. Leasehold use rights for land for (re)development are sold by city governments and are a key source of city revenue. Leasehold sales are viewed as a major venue for corruption, prompting a number of reforms over the years. Reforms now require all leasehold rights be sold at public auction. There are two main types of auction: regular English auction and an unusual type which we call a "two-stage auction". The latter type of auction seems more subject to corruption, or to side deals between potential bidders and the auctioneer. The paper finds correspondingly that sales prices are lower for two-stage auctions. However that could be because two-stage auctions have bad unobservables, or that there is negative selection into two-stage relative to English auctions. The theory suggests that in fact selection should be positive, as city officials divert hotter properties to a more corruptible auction form; and the paper finds strong evidence of positive selection into two-stage auctions. Consistent with the way corruption is modeled, the price difference is explained primarily by the fact that two-stage auctions typically have just one bidder, or no competition, despite the vibrant land market in Chinese cities.

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♣ Guanghua School of Management and IEPR, Peking University, China
♦ Department of Economics, Brown University
♥ Guanghua School of Management, Peking University, China

This paper studies the urban land market in China in 2003-2007. Urban land is owned "by the people" and its allocation done by the state.[1] In most cities, the local land bureau is responsible for the vast majority of allocations of land, allocated through auction sales of leasehold rights.[2] In China, land markets have been viewed as very corrupt, prompting a number of reforms over the years. We will provide some institutional context below but a couple of quotes illustrate that corruption is an on-going issue. In 2004, the *China Daily* wrote

> "China's Ministry of Lands and Resources announced new measures to crack down on corruption and inefficiency in the land sector. The new rules *forbid officials to receive personal benefits from parties under their administration* [italics added]. It is estimated that in 2003, the country faced 168,000 violations of its Land Law."

Yet in June 2008, the *Asian Times* reported

> "Chinese government efforts to clean up land sales, a major source of official corruption…, face a rethink.
> …Illegal transfers, corruption in land deals,…are rampant in major cities, according to an investigation published by the National Audit Office (NAO) last week.
> …Governments in the 11 cities [studied by the NAO], including Beijing and Shanghai, were also found to have misused 8.4 billion yuan from land-grant fees, Zhai Aicai, of the NAO, said in the report.
> ….Some cities have given a flexible interpretation to the rules and the auction system has often existed in name only, resulting in a lack of competition among developers and the winning developer being able to secure the land at below its true market value."

Today, after considerable reform, leaseholds are, in principle, all sold at public auction. There are two main types of auction in most cities: regular English auction and an unusual type of auction which we call a "two-stage auction." The raw data suggest that leaseholds sold at two-stage auctions sell at steep price discounts, relative to English auctions. Why are there such sales price differentials; and, related, how do city officials choose auction type for any particular property?

The paper argues that corruption in land markets in China takes the form of a side deal between one seller and a city official, rather than, say, bidding rings as in the USA.

[1] Rural land is owned by the village and allocations done by the village leadership.
[2] The central government (national asset committee) and the military may control portions of city land in particular cases, as for example the national capital Beijing.

As such we will argue that, in certain contexts, it is easier and more profitable with corruption to run a two-stage, as opposed to English auction. Corruption is realized as lower prices paid by the buyer in two-stage auctions, relative to what the same property would sell for in an English auction. This price difference of course could occur because properties with poor unobserved characteristics are sold in two-stage auctions. However we will show empirically that selection in fact is positive. We will argue theoretically that corrupt officials in maximizing their objective function are likely to divert "hot" properties to two-stage auctions and leave "cold" properties for English. Consistent with how we will model the corruption process, much of the price differential between auction types seems to be explained by the fact that two-stage auctions are much more likely to have just one (corrupt) bidder, or no competition, despite their benefiting from positive selection on unobservables and despite the vibrant land market in Chinese cities.

The paper is organized as follows. We start with essential background information on Chinese land markets and especially the two auction formats. We then present a conceptual framework to model the key differences between the auction formats. In section 3, we discuss the data and patterns in the data. Section 4 estimates a reduced form model of price differences between the two auction types, and discusses instruments for auction type used to estimate selection into auction type. In Sections 5 and 6, after accounting for joint selection into auction type and competition, we split the analysis of price differences into its two key components: whether a property is likely to have multiple bidders and sell competitively or not depending on auction type; and whether there are price differences across auction types, conditional on a property selling competitively.

## 1. Background

In the Maoist era and in the early reform years after 1978, land allocations were done by the state, with no market mechanisms involved. Starting in 1986, land administration changed with major reforms over the years (Ding and Knapp 2005, Valetta 2005). The first change was to charge new users for development rights and some incumbent users for use rights. After 1988, use rights for vacant land in the city were allocated through leaseholds, where, for a fixed sum, users obtained a long lease for a specified use (e.g., 70 years for residential land), subject to restrictions on intensity of development. In the 1990's, many of these allocations were done by "negotiation" in a hidden process, where reportedly leaseholds were often sold for a tiny fraction of market value. This had two consequences.

First, leasehold sales are a major source of revenue for many cities, in essence potentially being a full Henry George tax, allocating all "surplus" land rents to the city. For example, in 2004 and 2005 for Chengdu, Suzhou and Chongqing, leasehold sales revenues ranged from 2.6% to 5% of local GDP. Cities have an expenditure budget and on-the-book revenues. On-the-book revenues account for about 70% of total expenditures. Leasehold sales revenues are mostly off-the-book revenues, which are used to effectively close the on-the-book deficit. Negotiated sales at well below market prices deprived cities of major revenues.

Second, negotiated sales were reportedly inherently corrupt, resulting in some indictments of corrupt officials and a variety of reforms, one of which in 2004 was quoted above. Another reform in 2002 banned the secondary market for "land development rights," which had allowed large traditional holders (e.g., state owned enterprises) to, in effect, privately sell off their own land use rights (Zhu, 2004, 2005). Today the local land bureau is supposed to be in charge of almost all allocations of land for (re)development. Finally and most critically for this paper, a third recent reform was a 2002 law which banned negotiated sales by the land bureau, with the last date for any negotiated sales being August 31, 2004. For the last 4 years at least, all urban land leasehold sales are to be done through public auctions, with details of all transactions posted to the public on the internet.

How does the land market work? Local land use planning is done by an independent committee (albeit with 1-2 representatives from the land bureau on the committee). Given the overall land use plan for the city, at the beginning of each year, annual allocations are planned, based on existing urban land and converted rural land which should be ready for redevelopment during that year. Each plot of land is large with, in our sample, a median area of 22,300 square meters and a median sales price of USD $7 – 8 million.  The committee decides the use and other constraints (like floor-area ratio) of each plot to be sold. Once the land becomes available during the year, the committee sets the reserve price, using a formula based on the appraised value submitted by independent appraisal companies. Then the land is turned over to the land bureau which prepares it for sale (land for redevelopment in principle should be cleared), and chooses an auction type.

There are three types of auction used in China's land market. About 97% of sales in major cities are accounted for by two auction types, with the third type generally appearing only in Beijing and Shanghai. We ignore this third type of auction and our econometric specifications exclude Beijing and Shanghai.[3] The two main types are *guapai* which we call two-stage auction and *paimai* which is an English auction. English auctions are standard ascending bid auctions, usually publicly announced 20 working days before the auction. At announcement, basic details (e.g., use restrictions, reserve price, location) are publicized; and potential bidders for a small fee can obtain more detailed information, as well as inspect the site. Participation requires a cash deposit, usually about 10% of the reserve price, which is a non-trivial requirement given the large sizes and sales prices of such properties. English auctions are quite public, often video-taped with the press present. Winning bidders in principle must develop the land themselves.

As with English auctions, two-stage auctions are announced about 20 working days in advance; details of the plot are made public; and a deposit is required upon participation in the auction. A key difference is the auction format. With this type of auction, there are two-stages. The first stage normally lasts 10 working days after the auction starts. In the second stage, at the end of the 10 working days, if more than one bidder is competing for the property, the auction ends on the spot with an English auction

**3** The third type is sealed bid, or *zhaobiao* auction. There, bidders submit sealed bids to the land bureau, which decides the winner according to a complicated score function, in which the submitted bid usually accounts for only 20-30% in weight. The remaining 70-80% of the weight goes to the credibility of the bidder and how much social responsibility the bidder is willing to take. Credibility is mainly reflected in two aspects: one is the quality and reputation of the projects the bidder has developed in the past; the other is the bidder's financial capacity. As for social responsibility, this arises from Beijing's recent attempt to curb rising housing prices. If a bidder is willing to commit to an upper bound on the housing price of the future development on this piece of land, then this bidder will get a higher score in terms of social responsibility. In a logit framework in looking at auction choices, we did an early test on the validity of the IIA assumption that dropping this third auction type does not affect the analysis of the choice between English and two-stage auctions (Hausman-test of coefficient differences, when zhaobiao is added as a choice versus excluded). We could not reject the validity of the IIA assumption.

where only active bidders in the first stage are allowed to participate. If there is an ending English auction, it is generally less public than regular English auctions. In the first stage during the 10 working days between the starting date of the auction and the potential ending English auction, after obtaining qualification, people may submit ascending bids in person or on-line. Bids as they arrive are immediately posted on the trading board of the land bureau, as well as typically on the internet, although the identity of bidders is not posted. If, at the end of 10 working days, there is only one remaining bidder, that bidder is assigned the property at his bid price (but not less than the reserve price). Otherwise, with competition, the auction is converted to an English auction.

Tow stage auctions bear some resemblance to the jump bid scenarios analyzed in Avery (1998). In our setting, we will argue this first stage of a two-stage auction allows for early signaling to non-corrupt potential bidders that the auction has been "corrupted" and will potentially be dominated by a corrupt bidder (in league with the land bureau).[4] Early signaling will have a deterrence effect on any entry of non-corrupt bidders. Later we will argue that the signal will be a bid at reservation price by the corrupt bidder, the instant the auction is announced. There are two fuzzy parts to the two-stage auction format which we think permits the corrupt bidder to signal, because he alone may know the exact time the first stage of the auction starts and he alone may be qualified to submit a bid at that time. While the auction is announced *about* 20 working days in advance, the exact date of the start of the first stage of the auction may not announced at that time, but rather at an unspecified later date. Second, while bidders can apply during the announcement period before the first stage starts, approvals to participate can be delayed until after the first stage is under way.

As detailed below, we use data on 2302 auction transactions from 2003 to 2007 in 15 cities, which use both auction types (as opposed to having only two-stage auctions). In these cities English auctions account for 28% of auctions. In Figures 1 and 2 we present the indications from raw data that properties sell at a higher price under English as opposed to two-stage auctions, and that English auctions are much more likely to be

[4] We conducted surveys of the land bureau officials of 20 cities covered in our sample. In our survey, we asked questions regarding the differences in the mechanism between the two auction formats, in addition to differences in the pattern of bidding behaviors. We also asked how the land bureau chooses between the two auction formats for each piece of land for sale. Our theory conjectures in the next section are informed by our survey findings.

competitive. Figure 1 shows the distribution of unit sales price (price per sq. meter), by auction type for the sample; and Figure 2 shows the distribution of the ratio of sales to reserve prices. The raw data suggest that the distribution of unit sales prices for English auctions is shifted to the right of that for two-stage auctions. Of course, the distribution of raw unit sales prices does not condition on property and market characteristics. While differentials in property characteristics could explain price differentials across auction types, this will turn out not to be the case.

In Figure 2, two-stage auctions tend to be massed much more around 1.0 for "spread", which is the ratio of sales to reserve prices. Both conceptually and in a particular sub-sample analyzed below where we know the number of bidders, a ratio of 1 implies that there is just one bidder and thus no competition. Ratios larger than 1 in the sub-sample imply multiple bidders and what we term a competitive auction. Of course, whether there is competition or not is influenced by reserve price; so, if there are differentials in setting reserve prices across auction types, that might explain the differential pattern by auction type in Figure 2. However, reserve prices are set by the outside committee before the choice of auction type by the land bureau; and, as we will see below in Table 4, reserve prices do not seem to affect the choice of auction type.[5] Given that reserve prices are a fraction of assessors' estimates of true market values, a lack of competition is very surprising on its own. In these cities, auctions occur in a setting of rapid urban growth, with per capita urban incomes growing at about 10% a year and local population at 3-4 % a year. Given national restrictions on conversion of rural to urban land at the city fringes, this suggests there should be a high demand for land for new development.

In the next section we outline a simple conceptual framework, underlying our empirical hypotheses. In the following sections, we turn to the econometric formulation looking at auction choices, sales prices, and the degree of competition. We document and explore the price differences between English and two-stage auctions. As already noted a

[5] Despite the clear sequence, we looked at the possibility that reserve prices depend on auction type, in a MLE Heckman selection model where we allow auction type to be a determinant of reserve price. Controlling for selection effects of auction type yields an insignificant *rho*, suggesting no correlation between those unobservables affecting auction choice and those affecting reserve price.

key issue concerns selection of properties into auction type and whether properties with better unobservables are more likely (positive selection) to sold by two-stage auctions.

## 2. Conceptual framework

We start by stating some basic assumptions about the auction context and a brief review of some relevant known auction results. Then we specify the nature of corruption and analyze English and two-stage auctions under corruption. We end the conceptual section by comparing English versus two-stage auctions without corruption, although that analysis is more speculative.

### Basics of auctions

Assume for a leasehold auction there are *N* potential bidders, of which some endogenous number *n* pay an entry fee, *C,* and become active bidders.[6] A key issue is how the choice of auction format may influence *n.* We assume auctions are independent private valuation. Specifically, a potential bidder $i$'s valuation is $V_i = v_0 + v_i$, where $v_0$ is the (expected) common value that is the same for every bidder (based on property characteristics and local market conditions) and $v_i$ is the private value component only known to bidder $i$. $v_i$'s are i.i.d. [7]

We make the standard assumption that all bidders are risk neutral and maximize their expected payoff. Let $V_i \propto F(V)$ on $[0, \bar{V}]$ be the distribution function of the bidder i's valuation, and let $f(V)$ be the associated density function. A bidder's payoff when winning the auction with a bid $B_i$ is $U_i = V_i - B_i - C$.

To inform the modeling below, we review some key results concerning English auctions carried out without corruption. Given an English auction is outcome-equivalent to a second price Vickery auction, the setting is equivalent to that of Tan and Yilankaya (2006), who analyze a simultaneous move entry game in a second price auction with independent price valuations and participation costs. In a symmetric equilibrium of such a model a bidder will decide to enter the auction if and only if his valuation is above a

[6] The entry fee consists of (i) cost of making cash deposit to qualify, (ii) cost of preparing documents to meet the qualification requirements, (iii) other transaction costs (e.g., time, consulting fee).

[7] Since the (expected) common value is common knowledge to all participants, the auction is treated as one with independent private valuation.

certain value $\hat{V} > r + C$, where $r$ is the reserve price and $C$ is the entry cost. For a bidder with valuation exactly equal to $\hat{V}$, the only way he can get positive rent from entering the auction is if he is the lone bidder in the auction, in which case he gets a rent of $\hat{V} - r$. This case happens with probability $F(\hat{V})^{N-1}$, such that all other potential bidders have valuations below $\hat{V}$. Therefore, the valuation threshold for entry $\hat{V}$ must satisfy

$$F(\hat{V})^{N-1}(\hat{V} - r) = C. \tag{1}$$

From equation (1), we can solve for the valuation threshold for entry $\hat{V}$ in equilibrium that depends on $(r, C, N, \overline{V})$. Clearly, $\hat{V}$ is increasing in $r, C, N$.

The probability of selling at the reserve price is $NF(\hat{V})^{N-1}[1 - F(\hat{V})]$. Other possible outcomes in the auction are (1) that there are no bidders, which occurs with probability $F(\hat{V})^N$; and (2) that there are two or more bidders, so the auction is competitive with the winner being the highest valuation participant, *j*, who pays the second highest valuation $X_2^n(V_j)$ and makes an ex post rent $V_j - X_2^n(V_j)$. One can derive expected rents of entrants and expected revenue from the auction[8] .

**Form of corruption**

Suppose corruption arises in the following way. Under a corrupt sale, the land bureau official reaches an implicit agreement with a particular developer, say, developer 1, so that if he wins the land auction, she will provide special help (which could include weaker enforcement of development constraints or greater government investment in

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[8] In the bidding stage, each active bidder's valuation has the truncated density function of $g(V) = f(V)/[1 - F(\hat{V})]$ on $[\hat{V},\ \overline{V}]$. Let the associated distribution function be $G(V)$. Then the expected rent for active bidder $i$ from the bidding game is $u_n(V_i) = \iiint [V_i - X_2^n(V_i)]dG(V_{-i})$, where $G(V_{-i})$ denotes the joint distribution of other $n-1$ active bidders over the domain of $[\hat{V},\ V_i]^{n-1}$. In the entry stage, bidder $i$ with valuation $V_i \in [\hat{V},\ \overline{V}]$ expects that the number of active bidders (including himself) is $n = 1,\ 2,\ .\ .\ .,N$ with probability of $p_n = C_{N-1}^{N-n} F(\hat{V})^{N-n}[1 - F(\hat{V})]^{n-1}$, where $C_{N-1}^{N-n}$ denotes the combination of $N-n$ out of $N-1$. Thus, the total expected rent for bidder $i$ with valuation $V_i \in (\hat{V},\ \overline{V})$ from entering the auction is $U_i(V_i) = \sum_{n=1}^{N} p_n u_n(V_i)$. Expected revenue is $ER_1 = NF(\hat{V})^{N-1}[1 - F(\hat{V})]r + \sum_{n=2}^{N} p_n \iiint X_2^n dG(V_n)$.

relevant infrastructure), in exchange for a bribery payment. Let $Q$ be the value of the land bureau official's help to developer 1, and let $q \leq Q$ be the bribery payment developer 1 makes to the land bureau official, if he wins the auction. Define $\kappa \equiv Q - q$ as the net benefit to developer 1 from having an under-the-table deal with the land bureau official. In addition to a fixed bribe, we will consider also what might happen if the bribe is proportional to the buyer's surplus: his valuation minus the price he pays.

Assume the corrupt land bureau official's payoff function from the sale of a piece of land is given by

$$(1-\lambda)ER + \lambda q\omega + \delta D . \qquad (2)$$

In (2), $ER$ is the expected revenue from the land auction (that goes to the city coffers). This will depend on what auction format the official chooses; whether developer 1 and the land bureau official are in league with each other; and, if they are, whether developer 1 participates in the auction. $\lambda \in [0,1]$ measures how corrupt the official is. When $\lambda = 0$, the official is non-corrupt and seeks to maximize the expected revenue from the sale of land. When $\lambda$ becomes larger (closer to one), the land bureau official cares more about her own expected bribery income, $\omega q$, in the second term in (2) and less about the city's fiscal revenue. $\omega$ is the probability of the joint event that developer 1 and the official are in league and developer 1 enters the auction and wins. In terms of whether developer 1 and the land bureau official are in league, we assume for any land sale this occurs with probability of $p$. This reflects the likelihood the land bureau official in charge of a land sale is corrupt and she has a "partner" developer who is potentially interested in the land, where they must trust each other. Only the land bureau official and her partner know about any under-the-table arrangement; no other potential bidders know about it although under two-stage auctions they may infer it. The only thing the other potential bidders know a priori is that with probability $p$ the land bureau official and a developer are in league.

The last term in (2) as written is a non-negative benefit, $\delta$, which the land bureau official gets if she assigns a land sale to an English auction, with the indicator $D = 1$ if English, 0 otherwise. We will argue that two-stage auctions are more amenable to corruption. We believe this is widely known in city markets in China. We will see in the data it appears that, when under scrutiny, officials are more likely to choose English auctions. Thus a land bureau official worried about career advancement may experience a positive benefit to assigning a land sale to English auction, over and above the immediate income considerations. The value of $\delta$ may differ by city and time. In empirical work to follow, our instruments are chosen to indicate circumstances when land bureau officials are more concerned with appearing non-corrupt and more likely to choose English auctions. An alternative would be to make this last term a penalty if caught in a corrupt sale, where again its magnitude would differ by city and time.

**2.1 English auction under corruption**

While all potential bidders still make entry decisions simultaneously before the auction starts, let there be a potential bidder 1, who may have an agreement with the land bureau official. Then with probability of $p$ the auction is corrupt and his total valuation is $V_1 + \kappa$ ; and, with probability of $1-p$ the auction is not corrupt and his valuation is $V_1$.

In this context, let $\hat{V}_{1P}$ be the valuation threshold for entry for bidder 1 when corrupt, and let $\hat{V}_{-1}$ be the valuation threshold for entry for all other bidders.

With the possibility that bidder 1 is corrupt, bidders make entry decisions in an asymmetric bidding game. The condition is similar to equation (1) except now, while his evaluation is still based on the probability of there being no other non-corrupt bidders, he must allow for the fact that there may be a corrupt bidder. Given that, $\hat{V}_{-1}$ must satisfy the following equation:

$$F(\hat{V}_{-1})^{N-2}\{p[F(\hat{V}_{-1}-\kappa)-F(\hat{V}_{1p})]E\{(\hat{V}_{-1}-V_1-\kappa)\,|\,V_1\in[\hat{V}_{1p},\hat{V}_{-1}-\kappa]\}$$
$$+[pF(\hat{V}_{1p})+(1-p)F(\hat{V}_{-1})](\hat{V}_{-1}-r)\}=C. \qquad (3)$$

The bracketed expression on the left hand side represents a non-corrupt bidder’s expected rent in each of three cases: (i) the corrupt bidder enters but has an evaluation less than the non-corrupt entrant; (ii) the corrupt bidder 1 does not enter; and (iii) bidder 1 is not corrupt and does not enter. Note that the above equation assumes that if bidder 1 is not corrupt, he acts like any other bidder by using the same entry strategy.[9] If there is a corrupt bidder, his valuation threshold for entry $\hat{V}_{1P}$ satisfies

$$F(\hat{V}_{-1})^{N-1}(\hat{V}_{1p} + \kappa - r) + \sum_{q=1}^{N-1} w_q = C \qquad (4)$$

where $w_q$ is bidder 1's expected rent when his valuation is $\hat{V}_{1P} + \kappa$ and there are $q$ other bidders whose valuations are above $\hat{V}_{-1}$ but less than $\hat{V}_{1P} + \kappa$.

In evaluating the influence of corruption on a standard English auction, it can be shown that in equilibrium, $\hat{V}_{1P} < \hat{V} < \hat{V}_{-1}$, where $\hat{V}$ is the entry threshold absent corruption. The intuition is that thanks to the favor from the land bureau official, the corrupt developer 1 can afford bidding more aggressively and thus has a better chance of winning the auction. So he is more likely to enter ($\hat{V}_{1P}$ is lower than $\hat{V}$). Facing the possibility that bidder 1 may be favored, the other potential bidders are less likely to win and thus are less likely to enter ($\hat{V}_{-1}$ is higher than $\hat{V}$). The results can be shown as follows. Given equation (1) holds, by comparing equations (3) and (4), we have $\hat{V}_{1p} < \hat{V}_{-1}$. If $\hat{V}_{-1} \geq \hat{V}_{1p} + \kappa$, then equation (4) implies that $\hat{V}_{-1} > \hat{V}$ (note then that all $w_q$'s are zero). If $\hat{V}_{-1} < \hat{V}_{1p} + \kappa$, then for (1) and (4) to hold, equation (3) implies that $\hat{V}_{-1} > \hat{V}$ (note that the first term in the bracket is zero). Comparing equations (1) and (4) reveals that if $\hat{V}_{-1} \geq \hat{V}$, then $\hat{V}_{1p} < \hat{V}$.

We now turn to analyzing two-stage auctions under corruption. Then we compare the two auction formats under corruption, and examine whether corrupt land bureau officials are likely to steer hot versus cold properties to two-stage auctions.

### 2.2 Two-stage auction under corruption

In the two-stage auction, if the land sale is corrupted so that bidder 1 and the land bureau official are in league, bidder 1 acts as soon as stage 1 ensues. Since both would like to let

[9] This assumption holds when ex ante no one knows the identity of the potentially corrupt bidder, so that all potential bidders are symmetric if the government official is not corrupt. If everyone knows that bidder 1 is the only possible developer who can have a deal with government official, he is more likely to enter than other bidders (having a lower threshold) even when in fact he does not have a deal. This is because only bidder 1 knows that no one else is corrupt and all other bidders are worried that bidder 1 is corrupt. This latter case is not that realistic and the analysis will not change much if we allow for this possibility.

all other potential bidders know that this land is "claimed," a simple and natural way to send that signal is for bidder 1 to obtain pre-qualification (potentially with the land bureau official's help) and to make a bid right after the auction is started, before other potential bidders are granted qualification to bid, and perhaps even before they know that the auction has actually started. Since bidder 1 is only signaling that he has the agreement with the land bureau official, bidder 1 only needs to signal the agreement, by bidding just the reserve price (to increase the rent from winning the auction). When the extra help he gets from the land bureau official, $\kappa$, is relatively large, such signaling by bidder 1, if believed by other bidders, will seriously deter entry by other bidders since they see little hope of outbidding bidder 1.

We consider the following equilibrium. Let $\tilde{V}_C$ be the minimum threshold in which bidder 1 will send a signal by bidding the reserve price. If seeing that bidder 1 bids at the reserve price right after the auction is announced, all the other potential bidders understand that bidder 1's valuation is $V_1 + \kappa$, where $V_1 \in [\tilde{V}_C, \overline{V}]$. $\tilde{V}_C$ is the minimum valuation of the corrupt bidder so that he will bid in stage 1. As a simplification, other bidders decide simultaneously whether to enter. While other bidders could also decide in some arbitrary sequence in stage 1 whether to enter or not, we collapse that into a simultaneous decision to make calculations tractable. By construction, this staging also eliminates any potential snapping strategy by a non-corrupt bidder to also bid early, but such snapping is highly unlikely in the more general case if $\kappa$ is large, as illustrated in the Appendix.[10] If $\tilde{V}_0$ is the valuation threshold for all other potential bidders, it satisfies[11]

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[10] The issue is whether a bidder without an agreement with the land bureau official would be tempted to mimic the behavior of bidder 1 to scare away other bidders. Even if the snapper could manage to make a bid at the reserve price before the true corrupt developer, the latter is likely to make a higher bid in order to reclaim the land as long as $\kappa$ is relatively large. In such a case, the snapper will lose the auction and waste his entry cost. In the Appendix, we illustrate this argument in a simple example. When $\kappa$ is not sufficiently large, a non-corrupt bidder may try the snapping strategy when his valuation is very high for fear of being outbid by a corrupt bidder. It is possible that in equilibrium, a non-corrupt bidder with very high valuation and a corrupt bidder are pooled in using the same strategy of bidding at the reserve price at the start of the auction (whoever manages to be the first is immaterial). In such an equilibrium, a corrupt bidder who does not get the chance to submit a first bid will try to outbid the non-corrupt bidder only when he also has a quite high valuation. What is important, however, is that in such a pooling equilibrium, other bidders are seriously discouraged to enter, either by a very high valuation non-corrupt bidder or by a corrupt bidder.

[11] This assumes that, when their valuations are sufficiently high, other non-corrupt bidders may still enter the auction after seeing that corrupt bidder 1 has entered. Otherwise, the corrupt bidder 1's signaling can

$$F(\tilde{V}_0)^{N-2}[\frac{F(\tilde{V}_0-\kappa)-F(\tilde{V}_C)}{1-F(\tilde{V}_C)}]E\{(\tilde{V}_0-V_1-\kappa)\,|\,V_1\in[\tilde{V}_C,\tilde{V}_0-\kappa]\}=C \qquad (5)$$

where now a non-corrupt bidder knows if a corrupt bidder has entered ($V_1 \geq \tilde{V}_C$). Second, $\tilde{V}_C$ must satisfy an equation similar to equation (4) with $\tilde{V}_C$ replacing $\hat{V}_{1P}$ and $\tilde{V}_0$ replacing $\hat{V}_{-1}$. When no one bids at the reserve price right after the auction is announced, then bidders understand that the auction is not corrupted, in which case we have an ordinary English auction with *N-1* potential bidders.

**Comparison of English and two-stage auctions under corruption**

With a first day bid at the reserve price signaling a corrupted auction, non-corrupt bidders are less likely to enter a two-stage auction than an English auction and thus there is less likely to be competition. Correspondingly, bidder 1 is more likely to participate in a two-stage auction than an English auction. For the first we can show that $\tilde{V}_0 > \hat{V}_{-1}$ and for the second that $\hat{V}_{1p} > \tilde{V}_C$. The result can be shown by noting that, since equation (4) holds, if $\tilde{V}_0 > \hat{V}_{-1}$ then $\hat{V}_{1p} > \tilde{V}_C$. Suppose counterfactually $\tilde{V}_0 \leq \hat{V}_{-1}$, then it can be shown that the left hand of equation (4) is less than that of equation (2), which yields a contradiction (since the right hand sides of the two equations are the same).

The intuition is that in the case of an English auction, other potential bidders do not know whether bidder 1 is corrupt. They only know that he is corrupt with probability $p$, and they make entry decisions simultaneously with bidder 1. However, in the two-stage auction, the other potential bidders know for sure whether bidder 1 is corrupt or not. When he is corrupt, the other potential bidders have a much smaller chance of winning the auction since bidder 1 has substantial advantages from having a higher expected valuation from government help and having made the first bid. This reduces the incentives to enter for other potential bidders. Correspondingly, because other potential bidders are less likely to enter the two-stage auction, bidder 1 sees less risk of losing the auction and thus is more motivated to enter a two-stage auction (by posting a bid at the reserve price right after the auction starts) than an English auction.

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completely prevent entry by other bidders, and the difference between the English and two-stage auctions in terms of entry will be larger.

That the corrupt bidder is more likely but other potential bidders are less likely to enter a two-stage auction implies that the corrupt bidder has a better chance to win the land in a two-stage auction than in an English auction. In the Appendix we show that under all configurations of relative threshold values, the corrupt bidder is at least as likely to win in a two-stage auction and more likely is some configurations, compared to an English auction. Since the corrupt government official can get the bribery income only if the corrupt developer wins, ceteris paribus, she is more likely to favor two-stage auctions as $\lambda$ rises (caring about corruption income), or any corruption penalties fall.[12] As $\lambda$ falls, she is more likely to choose an English auction where competition with higher prices is more likely to prevail.

**Hot versus cold properties: positive selection**

Now we turn to the issue of positive selection on unobservables into the two-stage auction. The general idea is that, for hot properties, competition from non-corrupt developers makes it more difficult for the corrupt developer to win the land in the English auction. But as discussed above, the corrupt developer can fend off competition more easily in the two-stage auction by making a signaling bid. Therefore, a corrupt government official who cares sufficiently about her bribery payment is more likely to favor a two-stage auction over an English auction when the property to be sold is hotter. This suggests positive selection on unobservables into two-stage auctions.

Defining "hot" is non-trivial. The most straightforward way is to define it as the number of potential bidders, $N$, holding constant the common value and distribution function of valuations, and that is the example we will use here. But varying $N$ makes general analyses intractable and examples difficult to solve. Another way would be allow the common value to be uncertain to the land use allocation committee, but known to the land bureau official and bidders who operate daily in the market. For the same reserve price (related to the land use allocation committee's estimate of the common value) hotter properties are those with higher realized common values. Yet another way might be to have the corrupt bidder's valuation, $V_1$, known to the land official before auction choice

[12] Moreover, if the bribery payment to the government official increases with the partner developer's net profit, then they both are more likely to favor a two-stage auction, since the price the corrupt developer pays is likely to be lower.

and hotness defined on the size of $V_1$ (noting by construction the expected highest valuation of all participants rises as $V_1$ rises).

In using $N$ as the measure of hotness, the key idea is that we expect the positive difference in the probability that the corrupt developer wins the land between a two-stage and an English auction to rise with $N$, so that the gap in $\lambda q\omega$ terms between the two auction formats rises. However, this derivation (e.g., deriving $d\hat{V}_{-1}\big/dN$ and $d\hat{V}_{1p}\big/dN$ from equations (3) and (4)) turns out to be very difficult. So we illustrate with a special but relevant case. First to limit the complexity we avoid worrying about how the $(1-\lambda)ER$ portion of the land bureau's objective function changes, by assuming a $\lambda$ close to 1 so that the land bureau official is focused almost exclusively on corruption income.

Second, for our special case, suppose that $\kappa$ is sufficiently large, so that we are at or near a corner solution for two-stage auctions where $\tilde{V}_0$ is near or greater than the upper bound on valuations, $\overline{V}$. In this case, non-corrupt bidders will not enter the two-stage auction once they believe that a corrupt developer has secured an agreement with the corrupt government official. This seems to be a relevant case, given that the majority of two-stage auctions in the data have just one bidder. In this case, $\tilde{V}_C = C + r - \kappa$, and the corrupt developer wins the land with probability one as long as his valuation is above $\tilde{V}_C$. For the auctioneer then the value of her objective function under two-stage auctions doesn't vary [much] as $N$ varies for $\lambda$ equal [close to] 1.

However things are different for English auctions. Note from above that $\hat{V}_{-1} < \tilde{V}_0$, so that non-corrupt bidders entry point into English auctions may be well below $\overline{V}$, even if it isn't for two-stage auctions. Assuming $V_1 > \hat{V}_{1P}$ so that the corrupt developer is motivated to enter the English auction despite potential entry by other bidders, when $V_1 < \hat{V}_{-1} - \kappa$, the corrupt developer wins the land in the English auction with probability of $F^{N-1}(\hat{V}_{-1})$. It can be shown that this is decreasing in $N$. When $\hat{V}_{-1} \leq V_1 + \kappa$, the corrupt developer wins the land with probability of $F^{N-1}(V_1 + \kappa)$ in the English auction. Clearly, as $N$ becomes larger, the corrupt developer is less likely to win the land in the

English auction. Thus the gap in corruption income for two-stage auctions over English auctions will grow as $N$ grows. Then, as long as the auctioneer has sufficient preference for English auctions per se ($\delta > 0$ in (2)), where that preference will vary by city and time, cold properties will be assigned to English and hot to two-stage. Thus there will be positive selection on unobservables into two-stage auctions.

**Auctions without corruption: signaling**

We briefly discuss a comparison of English versus two-stage auctions absent corruption, in order to suggest that negative selection into two-stage auctions seems likely in the absence of corruption. We have noted the basics of English auctions without corruption in the text above. Two-stage auctions without corruption are more difficult although the analysis is related to Avery (1998). We detail analyses in the Appendix and give some intuition here. Now the first stage is a chance for a bidder to signal high valuation, not corruption. Given an entry fee (c.f., Ockenfels and Roth, 2002), the advantage of being able to bid early is that a bidder can potentially signal that she drew a relatively high private valuation. In contrast to the corruption case, we will suggest that the bid may signal her actual valuation. The signal is to discourage subsequent potential entrants who might have drawn somewhat higher valuations from entering the auction, because they then know that, if they enter, the prior signaler is prepared to bid up to her valuation. That inferred valuation then defines the minimum price they have to pay; thus signaling reduces expected rent of other potential entrants (their valuation minus the current signaler's valuation).

As with corruption, in the Appendix we show that the probability of no sale is lower in a two-stage auction than in an English auction. Since bidder 1 can discourage entry by other potential bidders with his early bid, he is more likely to enter in a two-stage auction than in an English auction. And when bidder 1 does not enter, other bidders still are more likely to enter a two-stage auction than an English auction.[13] The flip side of this is that the probability of competitive bidding (two or more active bidders) is lower

[13] The simultaneous entry game in an English auction suffers from coordination failure and a negative externality: bidders may not enter the auction even when their valuations exceed the reserve price plus entry cost, for fear of being outbid by others and the existence of another potential bidder lowers the probability of any potential bidder entering the auction. With signaling in a two-stage auction these problems are diminished, with bidder 1 having a stronger incentive to enter the auction

in a two-stage auction than in an English auction, because the early entrant may deter later entrants.

In terms of expected revenue, the comparison between two-stage and English auctions absent corruption is ambiguous, as can be seen in the Appendix. The intuition is that while a two-stage auction has a higher probability of sale, the likelihood of competitive bidding is smaller than in an English auction. Thus, depending on parameter values, the expected revenue of the two-stage auction can be greater or smaller than that of an English auction.

In the Appendix, we use an example to conjecture that when land is cold, as defined in a particular fashion, the expected revenue of a two-stage auction is greater than that of an English auction. When land is cold,, a two-stage auction has a relatively lower threshold entry for bidder 1 and greater likelihood of anyone entering. Thus any sale and some revenue are more likely under a two-stage auction. So then a two-stage auction may generally be a better choice of auction for a revenue-maximizing land bureau. If land is "hot", so a sale is very high probability, an English auction is likely to attract more bidders and competition, since two-stage auctions may still lead to entry deterrence. Thus we might expect a revenue-maximizing land bureau to steer hot properties towards English auctions. Thus overall, there would be negative selection on unobservables into two-stage auctions.

**Other auction choice considerations**

In an auction setting like ours, collusion among bidders (a group of developer forming a bidding ring) is quite plausible. In the existing literature, scholars have studied collusion in other auction settings (e.g., McAfee and McMillian, 1992, Bajari and Ye, 2003, and Athey, Levin and Seira, 2008).  While in China, a group of developers may be attempted to rig an auction, we don't consider in this setting for several reasons. [14] One is that the government's focus on corruption in land markets has not been on collusive bidding, but rather on corruption among officials. Correspondingly, as noted above, the instrumental variables for auction type used later relate to detection of corruption of state

[14] Also, there seems to be no reason why collusion among bidders would be more successful in a two-stage auction than in an English auction, so collusion among bidders would not explain the substantial difference in the likelihood of non-competitive bidding between the two-stage and English auctions observed in our data.

officials. A second is that, in China, it may be less appealing (more dangerous) for individuals to collude against the state per se, as opposed to collude with the state. It seems land bureau corruption is at the heart of any explanation of the positive selection.

Another factor that may affect the comparison between English and two-stage auctions is the riskiness of the land to be auctioned. For different properties, the variance of the private value components could differ. For a given reserve price, absent corruption, the land bureau might want to assign high variance properties to two-stage auctions. The reason is that, when there is a fat left tail of the distribution of $V_i$, the solution to equation (1) may be quite large, resulting in a low chance of a sale in the English auction. Thus revenue-maximizing officials would choose two-stage auctions for risky lands. This would suggest that two-stage auctions are associated with a higher probability of no sales. We observe the opposite in the data. Nevertheless, below we control for a number of observables which could be related to variance of valuations such as property type, size, and distance from the city center.

One additional issue we choose to ignore is the sequence of land sales in a city. First, while it is certainly true that developers can always bid on the next available land, land auctions differ from on-line auctions of staple goods in that land available for development in a particular city within a particular period of time is limited. Considering the heterogeneity of land and the heterogeneity of developers, a developer may not easily find many readily substitutable pieces of land and thus treats each auction seriously. Second, it does not seem to us that the issue of the sequence of land sales would fundamentally change our arguments about auction choices with or without corruption.

**What we see in the data concerning potential signaling**

In our data, in general, we know only sales and reserve prices and nothing about the bidding process itself—sequence and number of bids. However for Beijing we have a sample of 195 two-stage auctions, where we know the number of bids as well as the date when the first bid is submitted. From that data we learn several things. First, and most critically from Table 1, bidders do not signal valuations as they would in the absence of corruption. In all auctions with just one bid, almost all bids are within 0.5% of reserve price. This is consistent with our corruption story. Once we have 2 or more bids then a spread develops. This is the basis for later defining whether an auction is competitive (has more than one bid) or not, based on spread. Note auctions can be highly contested: in 26 of the cases with 3 or more bids, there are reported to be over 65 bids in each of the auctions.

Columns 1 and 2 of Table 2 show that, conditional on property characteristics, having a first day bidder reduces the number of bids, despite the positive bias (having a first day bid, given 10 days to bid, should mechanically raise the expected number of bids). Similarly, in columns 4 and 5, having a first day bidder makes it less likely that the auction will be competitive. Again this is consistent with the corruption story. But the first day bidder effects in columns 4 and 5 are weak. It turns out that in Beijing sometimes properties are sold which, contrary to national policy on auctions, have not been cleared for redevelopment. In Beijing, we have good data on clearance or not, with 155 of the observations having an entry for this variable. Being cleared increases the number of bids (column 3) and increases the chances of competition (column 6). Controlling for this variable sharpens the first day bidder variable in column 6.[15]

### 3. The data and basic patterns

For our econometric analysis, we have data for 15 cities from 2003-2007,[16] from the Land Bureau of China (or its branches at the city-level).[17] For each auction, the land bureau provides detailed information and posts it on its official website www.landlist.cn. Information includes: the address, the area (in square meters), the use restriction (business, residential, mixed), the type of auction, the reserve price, the sales price if the sale is complete, the post date which is the first date bids are accepted, the sale date, and the buyer's identity. Sometimes additional information is given, such as the maximum floor-to-area ratio, the building-density, the green coverage rate, and whether the property is cleared or not. For some items including the last, explicit information is only provided in a limited number of cases.

[15] Adding it to column 4 in fact yields an effect significant at the 5% level.

[16] These are Xiamen, Guangzhou, Shenzhen, Nanning, Changchun, Suzhou, Wuxi, Nanchang, Shenyang, Taiyuan, Chengdu, Tianjin, Hangzhou, Ningbo, and Chongqing.

[17] We exclude Shanghai, Beijing and Nanjing. Shanghai has no English auctions; Beijing has 1; and Nanjing 3 (which are a tiny fraction of sales). In all specifications we utilize city fixed effects, so within city variation in the data (in particular in auction formats which is our focus) is essential.

We also obtained the geo-economic characteristics of each piece of land for sale through bendi.google.com. Specifically, we locate each piece of land in the digital map of bendi.google.com using its street address. We then measure the line distance between the land and the CBD of the city where it is in. For the Chinese cities in the sample, we have no difficulty in identifying one central business district. We also create some dummy variables to indicate, whether within a 2.5 km. radius of the center of the property for sale, there is railway (including light rail and subway) or highway.

Our base data consists of 4016 listings, where a listing is a property put up for auction whether the auction is completed and results in a sale, or not. Our 4016 listings exclude industrial use land (about 7% of total listings). As in the USA, industrial land use has a low and highly variable unit price; regressions using USA data which examine the determinants of sales prices for industrial land have low explanatory power (DiPasquale and Wheaton, 1996). More critically in China, such properties are often sufficiently far from the city center stretching into peri-urban areas, that we couldn't get location characteristics from bendi.google.com.

Of the 4016 listings, 607 remain unsold. Another 1107, while sold, do not have information on either reserve price or sales price, or both. We focus on the remaining 2302 which are completed auctions with full price information. In the Appendix we explore the effect of focusing just on this sample. Here we note some key findings from the Appendix. First, for properties that sell, those with full versus deficient price information have similar unit and reserve sales prices where information does exist on one or the other and only differ in observables in two minor ways: properties without full price information tend to be older listings and nearer the city center. The differences in samples for sales with full versus limited price information seem to be "innocent." However, unsold properties compared to our working sample of 2302 show distinct differences. For example, unsold properties are more likely to have been offered at English auction potentially evidence of positive selection into two-stage auctions; and, not surprisingly, to have been listed more recently. In terms of sales dates, we suspect unsold properties (i.e., those which didn't sell 10 days after posting) are eventually removed from public listing on the internet, perhaps rebundled, and then relisted, which makes statistical analysis of sale versus no sale difficult, since we don't know which properties are being offered for the first versus second time.

**Differences across auction types**

Table 3 is summary of basic statistics about the data, for completed transactions by auction type. In Part a, compared to English auctions, two-stage auctions have significantly lower mean unit sales prices and are significantly less likely to sell competitively (have a spread greater than 1.005). However they have *no* significant difference *in unit sales price, conditional on a competitive sale.* This suggests that the main effect of two-stage auctions is to affect price by deterring entry and competition.

We note two-stage auctions have a greater proportion of commercial properties. However, we decided that whether a property was designated as commercial was not an element on which we wanted to focus. As Part b of the table reveals, commercial relative to residential and mixed use (which are fairly similar) properties are more likely to be sold through two-stage auction and without competition (60% sold non-competitively versus 40% for residential and mixed use). However unit sales prices across uses are similar, both for those that are sold competitively and for those that are not.

## 4. Baseline effect of auction type on sales prices

In this section we explore the overall effect of auction type on unit sales prices. As we will see in Sections 5 and 6, we are in essence estimating a reduced form price equation. Based on the conceptual section, consider the specification

$$\ln sale\ price = \ln common\ value + f\,(potential\ number\ of\ bidders,\ auction\ type,\ \tilde{e}) \quad (6)$$

This specification follows the notion that there is a common value component to any bidders' valuation. Given this common value, ex ante sales price then depends on the number of potential bidders and potentially the auction format, with the ex post sales price dependent on the actual drawings of private valuations (which $\tilde{e}$ encapsulates). In the data, the potential number of bidders and certain determinants of the potential number of bidders (e.g. certain property characteristics) are unobserved. Choice of auction format should be related to unobservables. With corruption, we have argued that there will be positive selection—the setting aside the most "delectable morsels" for corrupt participants. We also conjectured that absent corruption, there may be negative selection on properties sold by two-stage auction. Thus finding positive selection is both consistent with corruption and may also indicate corruption.

In equation (6), we assume reserve price is proportional to common value, with an added error component that is unrelated to any particulars of the sale ("evaluator error" in $\tilde{e}$). As noted above, reserve price is set by an outside committee, using a formula based upon the valuation of the land parcel carried out by an independent private land appraiser. In that sense reserve price is an exogenous valuation of property based on observed and unobserved (to us) aspects of the property and general local market conditions. For the same common values to two different properties, the number of potential bidders will vary with the city in question (number of active land developers, controlled below by city and time fixed effects) and aspects of the property. For example, the potential number of bidders may differ for certain types of uses or properties near or further from the city center.

We implement equation (6) with

$$\ln sale\ price_{ijt} = \ln ask\ price_{ijt} + \tilde{X}_{ijt}\beta + d_{ijt}D + u_j + \delta_t + \varepsilon_{ijt} \qquad (7)$$

for property *i* in city *j* which is sold at time *t*. $\tilde{X}$'s are observed property characteristics such as use restriction, area, and distance to the city center. Auction type, $d_{ijt}$, is whether the land bureau chooses a two-stage auction (=1) or not (=0), so that *D* is the effect of auction type on sales price, which we would like to identify**.** The dummy terms $u_j$ and $\delta_t$ capture city and yearn fixed effects. The arguments in $\varepsilon_{ijt}$ are unobserved time-varying city conditions or property characteristics, which controlling for common value (reserve price), may increase the number of potential bidders. These conditions may affect also affect selection of auction type.

**4.1 Selection problem and instruments.**

To deal with auction selection, for our baseline results, we estimate a Heckman (1978) endogenous dummy variable model by MLE, as well as with a selection control function based on the inverse Mill's ratio of a probit on auction type,[18] and by IV estimation.[19]

[18] The selection terms are respectively $\phi(Z_{ijt}\hat{\gamma})/\Phi(Z_{ijt}\hat{\gamma})$ and $-\phi(Z_{ijt}\hat{\gamma})/(1-\Phi(Z_{ijt}\hat{\gamma}))$ where $Z_{ijt}, \hat{\gamma}$ are the covariates and estimated parameters from the probit on auction type.

Instrumental, or control function variables are ones which we think affect selection of auction type by the land bureau, but not sales value conditional on our covariates.

We have four sets of instruments which appear to influence choice of auction type, but in the tables in the text we rely on just the two strongest. Each arises from a pattern in the data which is illustrated for the first set, as follows. In the month before a new party secretary takes office in a city, the land bureau switches more to using English auctions and then a month later it switches back, in fact switching away from English auctions (in effect, catching-up to its usual mix). We view this as the land bureau being cautious: "cleaning-up" temporarily in the face of uncertainty about the new party secretary's views on land market corruption; and then returning to business as usual. The same phenomenon occurs with the second set, although the timing is different.

For the second set, we have the number of cases per month that relate to real estate corruption in any city *j*, reported on Google China. Such cases could involve the removal of a major local government official, the indictment of officials, the execution of officials, or a criminal investigation on land transactions. During this month when a case occurs, officials are more careful and schedule more English auctions. A month later they again revert and catch-up to business as usual. A few months after the case, a sanitized report on the case (the average is about .03 reports per city per month) is announced on state run news agencies and picked up by Google China. The announcements on Google China appear to occur 3 months after the case, in the sense that 3 months earlier English auctions jump up, followed in the next month by a drop down. This timing of the pattern of one month up followed by one month down is found by experimentation in the data, but it is a clear pattern in both two situations.

We have two other types of instruments as well and include them in some experiments, especially in smaller sub-samples where there is insufficient variation in our 4 instruments across months within cities in the sub-samples. These results are in footnotes or mentioned in the text, but not in tables. We have a source on corruption

[19] We experimented with adding interactions of auction type with covariates to the IV specification, allowing auction effects to vary with covariates but the effects are not instructive, especially given we already have a reduced form specification. In OLS the interactions are not significant. In the IV (2SLS) results, the interactions are somewhat statistically stronger and the average treatment effect rises from -.53 (with 7 instruments) to -.81. However there is little variation in treatment responses as covariates go from low to high values.

investigations more generally, which is the number of news reports per month by the main state news agency in China, Xinhua, on corruption in any city $j$. Our hypothesized scenario is the city government, the local party, or the National Audit Office conducts an enquiry into local corruption, of which the local land bureau is fully aware. Again, during this month, officials are more careful and schedule more English auctions. A month later they again revert and catch-up to business as usual. A couple of months after the investigation, Xinhua reports on the investigation (the average is about .9 reports per city per month). Thus English auctions increase 2 months before the month of the news report and decrease the next month.

Finally, we have a measure of the pressure on the land bureau to raise more money through land sales. We measure the gap between budgetary expenditures of the city $E$ and on-the books revenue $R$. The instrument is the lagged growth in the relative deficit: $(E_{jt-1} - R_{jt-1}) / R_{jt-1} - (E_{jt-2} - R_{jt-2}) / R_{jt-2}$. With city fixed effects we would effectively be instrumenting with the lagged rate of change in this gap and are treating this growth rate as somewhat idiosyncratic and not connected to city demand conditions that would affect the current and future housing market (given city and year fixed effects). Higher lagged deficit growth rates induce more English auctions.

In summary, for the main results, we use just the first two sets of instruments: party secretary change and real estate corruption cases. There our vector of instruments $Z$ consists of dummy variables for any listing which occurs when a new party secretary takes office (one month lead and one month lag) and dummy variables for any listing which occurs when Google reports a land use corruption case (three months lead and two months lead). These are the strongest instruments. Growth in the relative city fiscal on-the-books deficit in the year before the listing is also a strong instrument at times but is potentially objectionable: it only varies annually and has the potential to be related to real estate prices. In addition to our results in the tables using 4 instruments, we will report (the almost identical) results for key situations using all 7 instruments. And as noted, in some experiments not reported in tables, we use all 7 instruments. We now look at first stage results of how instruments affect auction choice.

**Choice of auction type**

We examine the choice of auction type, both to see the role of the instruments and to analyze the choice itself. Results are in Table 4, for the situations with both 4 (column 1) and 7 (column 2) instruments. In both columns, the effect of reserve price on auction type is essentially zero, which is consistent with the idea that reserve price setting is independent of auction choice. Choice of auction type is significantly influenced by land use, where the base case, commercial land, is much more likely to be sold in two-stage auction, consistent with Table 3. Commercial land consists of smaller plots, which may be of more interest to specialized neighborhood developers within the city and may have fewer potential bidders. Also, more likely to be sold at two-stage auction is land near rails (probably land urbanized in the Maoist era) but not near highways (land urbanized more recently).

Of particular interest is how instruments influence auction choice. In column 1, the variables for the change in party secretary and for announcements of land corruption cases have the hypothesized patterns and are generally significant. In column 1, the *F*-statistic based on the change in the value of the LLF from adding instruments to the probit is 8.1. This is not as high as one would like, but it is reasonable in a context where we have city fixed effects. In column 2 the other three instruments are added in and have the hypothesized effects as well. However, going to seven instruments lowers the 1$^{st}$ stage *F*-statistic, one reason for settling on four instruments.

**4.2 Sales Price Results**

Sales price results are in Table 5. In all specifications, a 1% increase in reserve price raises sales price by just over 0.9%. Why is the elasticity less than 1? A higher reserve price also contains an effect to discourage entry of potential bidders (where we assume appraisers set a reserve price that is common value plus an idiosyncratic error component). Property characteristics are interpreted to affect the number of potential bidders, conditional on reserve price. Sales prices are distinctly lower for larger plots which may be less manageable, or have fewer experienced developers who would try to utilize them.

The key variable concerns choice of auction type. In OLS estimation, prices are lower for two-stage auctions by 17%. With correction for selection, the coefficient has a much larger negative value. The Heckman MLE estimate is about -0.70, about 4 times larger in absolute value. The fact that the treatment effect coefficients are significantly larger than under OLS suggests positive selection: not accounting for selection understates the size of the treatment effect. Correspondingly, for direct evidence on selection, the correlation coefficient in the MLE results is positive and significant. The theory section suggested positive selection would be a marker of corruption, and the results indicate that positive selection into two-stage auctions is a significant force.

In the table we also record 2-step Heckman and IV results. In the 2-step Heckman procedure, the Mills' ratio coefficient is positive and significant, again indicating positive selection. The Heckman 2-step and the IV (LIML) estimates of the auction effect are smaller in absolute value than the MLE estimate, but at -.41 and -.43 are still 2 ½ times the OLS estimate. In the table, instruments in the IV estimation are predicted probabilities from the first stage. The IV coefficient (standard error) when the first stage simply uses the 4 instruments (i.e., linear probability) is similar to MLE, -.646 (.267).[20]

We also examined the validity of instruments to the extent any tests are persuasive. If we add to column 1 (the OLS specification) our 4 instruments as covariates, the coefficient on auction type goes from -.1697 to -.1624, a tiny change. If instruments were correlated with unobservables affecting sale prices, assuming that auction type is correlated with unobservables, the added instruments should absorb some of the correlation of unobservables with auction type, affecting its coefficient. That the coefficient is unchanged and instruments are definitely correlated with auction type suggests that the instruments are orthogonal to unobservables. In IV estimation, the Sargan p-value of .15 while acceptable is low. We believe this is due to model specification error (see next section) rather than unsuitability of instruments per se.

Finally, we note that in early work we dropped the reserve price variable and used property characteristics (and city and time fixed effects) to represent both common value and demand considerations. In that specification, all coefficients become much more negative.[21] For example, the OLS coefficient goes from -.17 (with a reserve price control) to -.34 (without a reserve price control); the MLE coefficient goes -.92; and the

[20] With use of all 7 instruments, the MLE and 2-step Heckman results are almost the same as with 4 instruments (-.69 and -.46 respectively). The LIML estimates are higher in absolute value when using either a first stage probit or linear probability model (-.526 and -.893 respectively). All coefficients are significant.

T[21] These reported results are for 7 instruments.

LIML and Heckman 2-step coefficients are both about -.80. The *rho* in MLE and the *lambda* in the Heckman 2-step remain both positive. Results without a reserve price control also suggest positive selection.

**4.4 The problem with the baseline approach: "Kink/discontinuity" in the price equation**

We speculate that if multiple entrants emerge in the second stage of a two-stage auction, the outcomes for English and two-stage auctions for that property will be similar. In both cases once into the English auction portion, the sales price will simply be the valuation of the second highest valuation bidder. Corruption more likely takes the form of inducing non-corrupt entrants to stay out of the two-stage auction, with the result that sales are at reserve prices. Of the 2302 auctions upon which estimation is based, only 1235 are ex post competitive, or have more than one bidder as inferred from the degree of spread. A non-competitive auction means sales price equals reserve price, so reserve price tells us sales price. We already saw in Table 3 from the raw data that the significant overall unit price differences between English and two-stage auctions for the overall sample become insignificant once we look just at auctions which are competitive.

To explore these issues, we examine the two components. How does auction type affect the probability that an auction will be competitive or not? Second, if auctions are competitive does the choice of auction format still affect sales price? The answers to these questions will help us study the revenue losses from use of two-stage auctions.

**5. The effect of auction type on competition**

What is the effect of auction type, on whether an auction will be competitive or not, defined as whether there appears to be more than one bidder because spread exceeds 1.005? A simple probit of competitive or not with auction type as a potentially endogenous dummy variable faces the same selection problem as in the sales price estimation. Properties may be negatively or positively selected into two-stage auctions, and such selection itself will affect the potential for competition. The literature handles this in different ways. We use the bivariate recursive probit (Greene, 1998, Evans and Schwab, 1995), as an MLE solution. As a robustness check we also performed regular IV estimation in a linear probability model (Angrist, 1999), where we instrument for auction type with *Z*'s. There, the marginal two-stage auction effects are even stronger than we will report below—reducing the probability of competition by .75.[22]

The bivariate recursive probit is a two equation MLE model where we model action type as a dummy endogenous variable which is a function of *X* and *Z* , with auction type affecting the event: competition or not. That is,

$$d_{ijt}^{*} = Z_{ijt}\alpha + X_{ijt}\theta + u_{ijt}\,, \tag{8}$$

$$s_{ijt}^{*} = X_{ijt}\lambda + d_{ijt}\gamma + v_{ijt}\,, \tag{9}$$

with

$$d_{ijt} = \begin{cases} 1 & if\ d_{ijt}^{*} > 0 \\ 0 & o.w. \end{cases}, \tag{10}$$

$$s_{ijt} = \begin{cases} 1 & if\ s_{ijt}^{*} > 0 \\ 0 & o.w. \end{cases}. \tag{11}$$

where $d_{ijt}$ denotes whether an auction is two-stage (1), or not (0), and $s_{ijt}$ denotes whether an auction is competitive (1) or not (0). The *X*'s include city fixed effects, time dummies, seasonal dummies, and ln(*ask price*) in all equations (cf, equation 7). The recursive structure allows identification in a standard bivariate probit framework (Greene, 1998). In the next section we will add a continuous equation, for sales price in competitive auctions; at that point we will offer more details on estimation.

Results are in Table 6. For the bivariate recursive probit, we show marginal direct and indirect effects. For the variable of interest, two-stage auction, there is only a direct auction effect. In the ordinary probit, the marginal effect of two-stage auction on the probability of being competitive is -.34, consistent with the raw data in Table 3. In the bivariate recursive formulation that marginal effect is 26% stronger, at -.43.[23] This is again suggestive of positive selection into two-stage auctions: the two-stage auction's negative effect on competition is understated because properties with better unobservables are selected into two-stage auctions. Consistent with this, the *rho* measuring the degree of correlation between the error terms is positive (.38), and

[22] These results are based on use of 7 instruments, under LIML estimation.
[23] Use of 7 instruments further increases the strength of the negative effect to -.49.

significant. Properties with better unobservables are more likely to be competitive, and more likely to be assigned to two-stage auction.

In terms of other variables, relative to the base case of commercial use, sales of residential and mixed use land are likely to be more competitive, while large properties away from the city center are less likely to have competitive bidding. Total marginal effects on competition or not include direct effects[24] and then indirect effects[25] through the effect of covariates on auction type and hence competition. Indirect effects seem strongest for land use variables, reinforcing the fact that commercial use properties face fewer takers and are less likely to be competitive. Removal of reserve price as a covariate in both equations has little effect on results, consistent with the fact that its coefficient is insignificant in Table 6.

**6. Effect of auction format on sales prices, for competitive sales**

If properties sell competitively, is there a remaining effect of auction type on sales price? A naive way of looking at this is to ask, conditional on a property selling competitively, ex post does auction type affect price for such properties? That is interesting information. If we examine the sample of 1235 properties for which spread exceeds 1.005, OLS results in column 1 of Table 8 below show no effect of auction type, a coefficient of -.03.

This OLS estimate of auction effect on price faces two problems. First there is the auction selection problem discussed earlier, but now there is a second selection issue. Being competitive is endogenous, and there is selection on unobservables into competition that are surely correlated with price. Such selection is mediated by the auction process, so it is not the standard problem in Lee, Maddala and Trost (1980), but rather one modeled in the labor literature (Fraker and Moffitt 1988, Goux and Maurin, 2000) and more recently in firm growth models (Reize, 2001).

[24] Marginal direct effects are calculated based on the estimated coefficients in the second equation of the bivariate recursive probit, as well as the predicted probability of being competitive at the mean level of covariates, i.e., P=0.4817. For a continuous variable, its marginal effect is equal to the product of the density of normal distribution at P=0.4817 and its estimated coefficient. For a discrete variable, its marginal effect is equal to $\Phi(\arg\Phi(0.4817)+\theta)-0.4817$, where $\Phi(\cdot)$ (or $\arg\Phi(\cdot)$) is the cdf (or inverse of cdf) of the normal distribution and $\theta$ is the estimated coefficient.

[25] The marginal indirect effect of each covariate is obtained from the product of the estimated coefficient of two-stage auction in the second equation of the biprobit regression and the estimated coefficient of this covariate on auction type in the first equation. We calculate the standard errors using the delta method approach. The variance-covariance matrix is obtained through post-estimation of the biprobit model.

We tackle the problem in two ways. First, as a less parametric approach, we utilize the ideas from the literature on identification-at-infinity (Heckman, 1990), by examining auction effects for samples where the predicted probability of a non-competitive sale is small. This isolates a sample where, ex ante, we expect sales to be competitive regardless of auction type; and asks whether, for this sample, there is an effect on sales price of two-stage auctions. The main issue with moving to such samples is that, especially when we want to still correct for selection into auction type, we start to run out of cities which have competitive sales in both auction formats. Second, we estimate a parametric specification of the two selection issues by MLE.

**6.1 Selection into being competitive**

**Identification-at-infinity**

Similar to Mulligan and Rubinstein (2007), for each auction type *separately*, we estimate the probability that an auction is competitive; specifically that the spread (ratio of sales to reserve price) is greater than 1.005. The covariates are the *X*'s including reserve price and city fixed effects, but not the instruments (which don't affect competition per se). We then created different samples: for example all properties where the probability of competition ex ante is predicted to be greater than 0.5, 0.6, 0.7, and so on. Patterns in the raw data are most instructive in terms of how the samples, mix of competitive to non-competitive auctions, and price differences change across auction types as we move to more and more competitive margins.

Table 7 shows the patterns. In Table 7 we distinguish 7 samples, all observations and then 6 samples distinguished by increasing degrees of predicted competitiveness of the auctions. We have three sets of columns. In the first we show that as the degree of predicted competitiveness increases, the ratio of (remaining) two-stage to English auctions declines precipitously. For the full sample the ratio is 2.6; for the most competitive it is 0.06. The result suggests that finding a sufficient sample of two-stage auctions that are very likely to be competitive is not easy. The second set of columns shows that as we increase the margin on being competitive, the percentage of auctions with spread rises and converges for the two auction types. This of course follows from the nature of the exercise (creating samples by how competitive they are predicted to be); but it shows the exercise is working.

The third set of columns in Table 7 contains the key results. It examines the pattern of spread (sales to reserve price) for English versus two-stage auctions. Significant differences in both median and ranks of spread exist at low levels of competition between the two auction types, but diminish as competition increases and disappear by a predicted probability of competition in excess of 0.7. Typically, for identification-at-infinity, a margin of .8 or greater is used. The raw data suggest that at such margins, English and two-stage auctions yield similar outcomes.

We then attempted to implement this idea econometrically, by looking at sales which ex ante are “almost certain” to be competitive. The difficulty is that as we make the margin of competition more intensive, we get fewer and fewer two-stage auctions in the sample, so there are fewer and fewer cities left in the sample which use both auction types. Second our instruments loose their power and degree of variation as the sample shrinks and what we report is the best case—use of all 7 instruments. In this case, even if we cut at the probability of being competitive at a relatively low level such as 0.7, the first stage probit drops all but 3 of the 7 instruments (lack of variation in instruments under city and time fixed effects); and of the 715 sales where the probability of competition exceeds .7 (Table 7), only 541 are in cities which still use both auction types. The improvement in the LLF from adding these instruments has a $\chi^2$ - statistic of 2.09 which falls far short of the critical value of 7.8 with 3 degrees of freedom, and the corresponding *F*-statistic is tiny. If we cut finer in terms of increased degree of competition, we loose most variation in instruments and the problem is worse.

The best we can do is cut at the margin of the probability of competition exceeding .6, which definitely falls short of identification-at-infinity. For these sales we have a sample 792 (out of possible 912 from Table 7) where 9 cities still have both auction types. While all 7 instruments have variability in the sample, the improvement in the LLF for the first stage probit on auction type of adding the instruments is still significant ($\chi^2$ - statistic of 28.5) but the implied *F*- statistic indicates weak instruments. For this sample, in the same type of price equation as used in Table 5, the coefficient on auction type under MLE Heckman estimation is -.31 and significant. But that coefficient is almost the same as the OLS one of -.29 and *rho* equals .028 (and is insignificant). There is no evidence of selection into auction type for this sample. While the effect of auction type on price for this more competitive sample is now much smaller than the -.70 in Table 5, it is not zero. Unfortunately we can't use this approach to tease out the effect when we are at the margin of properties which are "almost certain" to sell competitively, to see if the effect goes to zero. Thus we turn to the more traditional parametric approach.

**6.2 MLE estimation of the bivariate selection into competitive, two-stage auctions**

To the model in equations (8) – (11), we now add a third equation for price

$$y_{ijt} = X_{ijt}\beta + d_{ijt}D + \varepsilon_{ijt} \quad if \;\; s_{ijt} = 1, \qquad \text{(7a)}$$

where $y_{ijt}$ is sales price in logs. The structure imposes a trivariate normal error

$$\sum = Var\begin{pmatrix} \varepsilon \\ u \\ v \end{pmatrix} = \begin{pmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon u} & \sigma_{\varepsilon v} \\ \sigma_{\varepsilon u} & 1 & \sigma_{uv} \\ \sigma_{\varepsilon v} & \sigma_{uv} & 1 \end{pmatrix}, \qquad \text{(12)}$$

so as to estimate the parameter set $\Theta = \left(\beta \; D \; \alpha \; \theta \; \gamma \; \sigma_\varepsilon \;\; \rho_{\varepsilon u} \; \rho_{\varepsilon v} \; \rho_{uv}\right)$. The LLF is footnoted and uses results in Genz (2004).[26]

We estimate the model by MLE, which yields more efficient estimates than a two step approach that adds two control functions to the price equation to deal with the two dimensions of selection; the two-step approach also has a cumbersome standard error calculation (Reize, 2001).[27] In Table 8, column 2, we present the results for the price

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[26] The LLF is

$$\ln L = \begin{cases} \ln(\Phi_2[-Z_{ijt}\alpha - X_{ijt}\theta, -X_{ijt}\lambda - d_{ijt}\gamma, \rho_{uv}]) & if \;\; d_{ijt} = 0,\, s_{ijt} = 0 \\ \ln(\Phi_2[Z_{ijt}\alpha + X_{ijt}\theta, -X_{ijt}\lambda - d_{ijt}\gamma, -\rho_{uv}]) & if \;\; d_{ijt} = 1,\, s_{ijt} = 0 \\ \ln(\Phi_2[-p_{dijt}, p_{sijt}, -\rho_{ds}]) - \frac{1}{2}\ln(2\pi) - \ln(\sigma_\varepsilon) - \frac{1}{2}\left(\frac{y_i - X_{ijt}\beta - d_{ijt}D}{\sigma_\varepsilon}\right)^2 & if \;\; d_{ijt} = 0,\;\; s_{ijt} = 1 \\ \ln(\Phi_2[p_{dijt}, p_{sijt}, \rho_{ds}]) - \frac{1}{2}\ln(2\pi) - \ln(\sigma_\varepsilon) - \frac{1}{2}\left(\frac{y_i - X_{ijt}\beta - d_{ijt}D}{\sigma_\varepsilon}\right)^2 & if \;\; d_{ijt} = 1,\;\; s_{ijt} = 1. \end{cases}$$

$\Phi_2(.)$ is the cumulative density function of the bivariate normal distribution. And

$$p_{dijt} = \frac{Z_{ijt}\alpha + X_{ijt}\theta + \frac{\rho_{\varepsilon u}}{\sigma_\varepsilon}(y_i - X_{ijt}\beta - d_{ijt}D)}{\sqrt{1-\rho_{\varepsilon u}^2}}, \; p_{sijt} = \frac{X_{ijt}\lambda + d_{ijt}\gamma + \frac{\rho_{\varepsilon v}}{\sigma_\varepsilon}(y_i - X_{ijt}\beta - d_{ijt}D)}{\sqrt{1-\rho_{\varepsilon v}^2}}, \text{ and}$$

$$\rho_{ds} = \frac{\rho_{uv} - \rho_{\varepsilon u}\rho_{\varepsilon v}}{\sqrt{(1-\rho_{\varepsilon u}^2)(1-\rho_{\varepsilon v}^2)}}.$$

[27] We thank Frank Reize for access to his STATA code on MLE estimation of the model, to check ex post against our STATA code, although in the end we reprogrammed the model in MATLAB. There seems to be a minor error in Reize (2001) in specification of the LLF.

equation, along with the covariance structure. Estimates for the discrete choice part are in the three-equation MLE Appendix. For comparison in the Appendix, we also report the corresponding bivariate recursive probit estimates from which Section 5 and Table 6's marginal effects are calculated. The two sets of coefficients are very close.

Results on the price equation in Table 8, column 2 are similar to the OLS estimates without any sample corrections. The coefficient for the auction type effect on price in competitive auctions is fairly close to zero and insignificant, as hypothesized.[28] In the covariance structure, as before, there is strong positive selection into two-stage auctions. The error term on the price equation has low correlation with the error terms on the discrete events.

**Summary.** Whether we approach the problem as a parametric one with strong assumptions or use a more non-parametric approach (identification at infinity on raw price data or in a price equation with auction selection), it seems that, once auctions become competitive, price is not affected by auction format. Auction format matters at the margin of whether auctions are competitive or not, all consistent with the corruption signaling hypothesis associated with two-stage auctions

**6.3 Review gains from switching to English auctions**

What are the revenue gains if one was to require properties sold at two-stage auction to be sold at English auction, assuming that would solve the problem of potential corruption between the auctioneer and partner bidders. In our data the actual revenue from properties sold at two-stage auctions is 239.6 billion Yuan or about $34.2 billion. This is modestly higher than the expected revenue for these properties which is predicted from the estimated model, indicating the issue with mediating unit sales price predictions by lot sizes to get sales revenue per property. This predicted revenue if these properties are still sold at two-stage auction is 227.7 billion Yuan, about 5% lower than the actual. The unit sales price calculation is based on the predicted probability of selling competitively if sold at two-stage auction ($\text{prob}(\langle s_{ijt} = 1 | d_{ijt} = 1 \rangle)$) times the predicted price if sold competitively, plus the predicted probability of selling non-competitively at two-stage auction times the reserve price. The predicted price if sold competitively is

[28] The results are the same if we use 7 instruments.

calculated from the usual price equation adjusted for the two selection terms as footnoted (using parameters from the MLE estimation).[29]

We compare the revenue from selling properties by two-stage auctions with the predicted revenue obtained if all properties sold by two-stage auctions in the data were sold at English auctions. This is the predicted probability of these properties selling competitively if switched to English auction times the predicted price when sold competitively, plus the predicted probability of not selling competitively if switched to English auction times the reserve price. The predicted probability of selling competitively is enhanced by the treatment effect of English auction on competition.[30] The predicted revenue is 299.6 billion Yuan. This is 25% higher than the actual revenue and 32% higher than the model predicted revenue if sold by two-stage auction. Thus, use of two-stage auction with the associated reduction in degree of competition (through potentially signaling a corrupt sale) deprives cities of significant revenues.

This gain in revenue is illustrated in Figure 3, which for two-stage auctions compares the predicted unit price in the model if sold by two-stage auction, with that if sold by English auction. The 45$^{o}$ line is for model predicted prices if sold still at two-stage auction, while the scatter plot of points is for the predicted prices if these properties were sold by English auction. The difference reflects both the increase in probability of selling competitively for any property, as well as the fact that these properties have relatively good unobservables which enhances their competitive price.

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[29] The price equation is $\hat{y}_{ijt} = X_{ijt}\hat{\beta} + d_{ijt}\hat{D} + \hat{c}_{u,ijt}\hat{\sigma}_{\varepsilon u} + \hat{c}_{v,ijt}\hat{\sigma}_{\varepsilon v}$ , where $\hat{c}_{u,ijt}, \hat{c}_{v,ijt}$ are the predicted values for the expressions

$$
\begin{aligned}
c_{u,ijt} &= \phi[Z_{ijt}\alpha + X_{ijt}\theta]\frac{\Phi[X_{ijt}\lambda + d_{ijt}\gamma - \rho_{uv}(Z_{ijt}\alpha + X_{ijt}\theta)]/(1-\rho_{u\upsilon}^2)^{1/2}}{\Phi_2[Z_{ijt}\alpha + X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, \rho_{uv}]} \text{ if } d_{ijt} = 1 \\
&= \phi[-Z_{ijt}\alpha - X_{ijt}\theta]\frac{\Phi[X_{ijt}\lambda + d_{ijt}\gamma - \rho_{uv}(Z_{ijt}\alpha + X_{ijt}\theta)]/(1-\rho_{u\upsilon}^2)^{1/2}}{\Phi_2[-Z_{ijt}\alpha - X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, -\rho_{uv}]} \text{ if } d_{ijt} = 0 \\
c_{v,ijt} &= \phi[X_{ijt}\lambda + d_{ijt}\gamma]\frac{\Phi[Z_{ijt}\alpha + X_{ijt}\theta - \rho_{uv}(X_{ijt}\lambda + d_{ijt}\gamma)]/(1-\rho_{u\upsilon}^2)^{1/2}}{\Phi_2[Z_{ijt}\alpha + X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, \rho_{uv}]} \text{ if } s_{ijt} = 1 \\
&= \phi[X_{ijt}\lambda + d_{ijt}\gamma]\frac{\Phi[-Z_{ijt}\alpha - X_{ijt}\theta + \rho_{uv}(X_{ijt}\lambda + d_{ijt}\gamma)]/(1-\rho_{u\upsilon}^2)^{1/2}}{\Phi_2[-Z_{ijt}\alpha - X_{ijt}\theta, X_{ijt}\lambda + d_{ijt}\gamma, -\rho_{uv}]} \text{ if } s_{ijt} = 0
\end{aligned}
$$

[30] Let us denote the probability of selling competitively under the switch as $\text{prob}[s_{ijt} = 1 \mid d_{ijt} = 1, d'_{ijt} = 0]$. Then $\text{prob}[s_{ijt} = 1 \mid d_{ijt} = 1, d'_{ijt} = 0] = \Phi\left(\Phi^{-1}(\text{prob}[s_{ijt} = 1 \mid d_{ijt} = 1]) - \hat{\gamma}\right)$.

## 7. Summary

To the best of our knowledge, this paper is the first to investigate empirically corruption in auctions beyond simple price-fixing among bidders, to allow corrupt auctioneers and signaling activity. This complements the recent increased interest in the theoretical literature on corruption in auctions (see, e.g., Burguet and Che, 2004, Compte, O., A. Lambert-Mogiliansky and T. Verdier, 2005, Menezes and P. K. Monteiro, 2006). But our paper differs also from this theoretical literature. Corruption in our context takes the form of auction choice, while these theoretical papers consider corruption in a given auction format. Another difference is that both English and two-stage auctions are open (that is, all bids are observable to all participants), while the existing literature considers first price sealed bid auctions (so that the corrupt auctioneer can manipulate bids).

In this setting, we show that after controlling for observable land characteristics (and location and time trends), two-stage auctions lead to less competitive bidding and thus substantially smaller revenue than English auction in China's land market. We further demonstrate that land bureau officials in Chinese cities divert hotter properties to two-stage auctions that are more corruptible. Since urban land in large Chinese cities is hugely valuable and revenue from land auctions accounts for a large portion of city fiscal revenue, such corruption activities result in large losses of potential public funds. And the losses from this type of corruption are not merely transfers from city coffers to the corrupt officials and developers. It can lead to serious misallocations, as honest developers with higher valuations are deprived of the chances to develop the land.

China's reform mandating auctions for land transactions was a big step in the right direction in fighting widespread corruption. However, our analysis of China's land market shows that in a weak institutional environment, corruption cannot be curbed by a few simple "technical" fixes. Corrupt government officials and their partners in the business world can and will find cracks in the new fixes. In the context of China, recent studies have identified other "tricky" cases of corruption and illegal activities, for example, tariff evasion using entrepot trade (Fisman and Wei, 2004, Fisman, Moustakerski and Wei, 2008) and corruption and bribery using travel and entertainment expenses (Cai, Fang and Xu, 2009). Thus, fighting corruption in developing countries like China is a long term process whose success relies on, and is a part of, the gradual improvement of overall institutional environment.

## Appendices

**Theory appendix:**

### 1. Comparing English and two-stage auctions under corruption

Suppose that the corrupt government official chooses auction format after learning about the valuation of her partner developer (developer 1), $V_1$. Even if she does so before learning about $V_1$, the analysis below still goes through because she will just take expectation over $V_1$, which does not affect the logic of our argument. When $V_1$ is smaller than the entry threshold in the two-stage auction, $\tilde{V}_C$, then the corrupt developer will not enter no matter what auction format is chosen. When $V_1 \geq \tilde{V}_C$ but $V_1 \leq \hat{V}_{1P}$ (the entry threshold in the English auction), then the corrupt developer will enter the auction only if the corrupt government official chooses the two-stage auction. Thus, to have a positive chance of obtaining corruption payment, the corrupt government official will choose the two-stage auction when $\tilde{V}_C \leq V_1 \leq \hat{V}_{1P}$. Now consider the case in which $V_1 > \hat{V}_{1P}$ so that the corrupt developer is willing to enter no matter what the auction format is. Let $X_1^{N-1}$ denote the highest valuation of all N-1 non-corrupt potential bidders. The probability of the corrupt developer wining the auction depends on the realized value of of $X_1^{N-1}$. If $X_1^{N-1} \leq \hat{V}_{-1} < \tilde{V}_0$, where we recall $\hat{V}_{-1}$ ($\tilde{V}_0$) is the entry threshold of a non-corrupt bidder in the English (two-stage) auction, then none of the non-corrupt bidders will enter either auction format in this event and the corrupt developer wins the auction without contest. If $\hat{V}_{-1} < X_1^{N-1} < \tilde{V}_0$, then the non-corrupt bidder with the highest valuation will enter the English auction but not the two-stage auction. In this event, the corrupt developer wins the auction without contest if the two-stage auction is chosen, but may face competition from some non-corrupt bidders and may lose the auction if $X_1^{N-1} \geq V_1 + \kappa$. Finally, if $\tilde{V}_0 \leq X_1^{N-1}$, then the non-corrupt bidder with the highest valuation will enter to contest the corrupt developer under either auction format. No matter what the auction format is, whether the corrupt developer can win the auction depends on whether $V_1 + \kappa$ is greater than $X_1^{N-1}$. In summary, in all events, the probability of the corrupt developer winning the auction is not less and sometimes greater under the two-stage auction than under the English auction. Therefore, when $\lambda$ is close to one, the corrupt government official who predominantly cares about her corruption payment will choose the two-stage auction over the English auction.

### 2. The snapping strategy by a non-corrupt developer does not work: an example

Assume a uniform distribution on $[0, \bar{V}]$. Suppose $\kappa$ is sufficiently large so that other bidders will not enter if they see a bid at the reserve price at the start of the auction. Suppose a non-corrupt bidder plays the snapping strategy by mimicking the corrupt bidder when his valuation is above $\breve{V}$. We consider the bidder with the threshold valuation. A corrupt bidder will outbid him if $V_1 \geq 0.5(\breve{V} + \bar{V}) + C - \kappa$, which happens with probability of $p^* = p[0.5(\bar{V} - \breve{V}) - C + \kappa]\big/\bar{V}$. With the remainder probability, he succeeds and obtains a payoff of $\breve{V} - r - C$. Thus, playing the snapping strategy yields an expected payoff of $(1 - p^*)(\breve{V} - r) - C$. Now suppose this bidder who contemplates the snapping strategy plays the equilibrium strategy of waiting to see whether there is a corrupt developer who submits a bid at reserve price at the start of the auction. It is reasonable to suppose that when no corrupt developer submits a bid at reserve price at the start of the auction, this bidder is the first one to submit a signaling bid in the two-stage auction without corruption. For simplicity, let us consider the case of low valuation scenario when $\bar{V} \le r + 2C$ in the previous example. In such a case, the non-corrupt bidder with valuation $\breve{V}$ who plays the equilibrium strategy obtains an expected payoff of $(1 - p)(\breve{V} - r - C)$, because in the low valuation scenario he can prevent competition by bidding at the reserve price (see the previous section).

For the threshold valuation $\breve{V}$, it must be that $(1 - p^*)(\breve{V} - r) - C = (1 - p)(\breve{V} - r - C)$. Simplifying terms yields $(0.5\bar{V} + 0.5\breve{V} + C - \kappa)(\breve{V} - r) = C\bar{V}$. Clearly $\breve{V}$ increases in $\kappa$. It can be checked that when $\kappa \ge \bar{V} + C - \dfrac{C\bar{V}}{\bar{V} - r}$, then $\breve{V} \ge \bar{V}$, in other words, it does not pay for a non-corrupt bidder to play the snapping strategy.

## 3. Characterizing a separating equilibrium of a two-stage auction without corruption

In a non-corruption context, entrants, in arbitrary sequence, have a first opportunity to submit a bid. Sequencing could be based on the arbitrary times at which potential bidders learn the auction has started and decide to enter in the first stage, and have had their application to bid approved. Solving the general case with endogenous first stage entry is daunting—whether an early entrant signals with what bid function, whether later entrants with higher valuations enter or not, and the complicated interactions between early and later signalers. We work with a special case where of the $N$ potential bidders, only one randomly selected person, labeled bidder 1, has the option to enter and bid early. This case also models the general situation in which $N = 2$ (the intractability of the general case arises when $N > 2$). We solve for a separating, signaling equilibrium, where bidder 1 signals his true valuation.

Fort a possible separating signaling equilibrium, suppose bidder 1 chooses to enter in stage 1 by using a strictly increasing bidding schedule $B(V_1)$ when his valuation is $V_1 \in [\tilde{V}, \bar{V}]$. For $V_1 < \tilde{V}$, bidder 1 will choose to not enter the auction. Suppose his valuation is exactly $\tilde{V}$. Based on the Riley argument in the signaling literature, bidder 1 should use the lowest possible signal, the reserve price $r$. Moreover, in order for bidder 1 not to choose this signal when his valuation is just below $\tilde{V}$, his expected payoff from entering and signaling must be zero. Once bidder 1 bids $r$ and reveals that his valuation is $\tilde{V}$, other potential bidders will enter only if their valuation is above $\hat{V}_S(\tilde{V})$, the solution to equation (1) with $\tilde{V}$ replacing $r$ and $N - 2$ replacing $N - 1$. Other potential bidders understand that to win they must outbid bidder 1; but since bidder 1 has committed to enter the auction, he is willing to bid all the way to his valuation $V_1 = \tilde{V}$. Thus, for the other potential bidders*, the effective reserve price increases to* $V_1 = \tilde{V}$. Bidder 1 can win the auction only if no other potential bidders enter the auction, which happens with probability of $F(\hat{V}_S(\tilde{V}))^{N-1}$. Therefore, we must have

$$F(\hat{V}_S(\tilde{V}))^{N-1}(\tilde{V} - r) = C. \quad \text{(A1)}$$

Note that since $\hat{V}_S(\tilde{V}) > \tilde{V} + C$, comparing (A1) and (1) reveals that $\tilde{V}$ is smaller than $\hat{V}$, so the threshold entry level is lower in a two-stage auction.

In the bidding game if bidder 1 does not enter in the first stage, the other $N-1$ potential bidders play the same game as in an English auction: they first decide on whether to enter in the second stage simultaneously, and then the active bidders bid in the English auction. Exactly as above, we can solve for the valuation threshold for entry, denoted by $\hat{V}_{NS} = \hat{V}(r, C, N-1, \overline{V})$. Note that $\hat{V}$ is increasing in $N$, thus $\hat{V}_{NS} < \hat{V}(r, C, N, \overline{V})$, which is the equilibrium entry threshold in the case of an English auction with $N$ potential bidders.

So far we have just looked at the border case where bidder 1's evaluation exactly equals $\tilde{V}$ and he bids *r*. What happens if bidder 1's evaluation $V_1$ exceeds $\tilde{V}$? We argue that when bidder 1 has valuation $V_1 \in [\tilde{V}, \overline{V}]$, he has a bidding function that is strictly increasing in $V_1$ and truthfully reveals his valuation. Such a bidding function satisfies the single crossing property, so it isn't beneficial for lower valuation bidders to pretend to be higher types. Note that bidder 1 with $V_1 \in [v_0, \tilde{V})$ will not enter the auction at all. Consider a bidder 1 whose valuation is just below but very close to $\tilde{V}$. In equilibrium he does not enter and all other potential bidders understand that his valuation is below $\tilde{V}$. So other bidders enter the English auction if their valuation is above $\hat{V}_{NS}$. Thus, if this bidder 1 deviates from the equilibrium and enters the English auction at the end, his expected payoff will be no more than $F(\hat{V}_{NS})^{N-1}(\tilde{V} - r) - C$, which will be less than zero by equation (A1) since $\tilde{V}_{NS} < \hat{V}_S(\tilde{V})$.

Now we consider the case when $V_1 \geq \tilde{V}$. If bidder 1 enters in stage 1 with a bid $B_1$, the other potential bidders can infer bidder 1's valuation $V_1 > B_1 + C \geq r + C$ from his bidding schedule $B(V_1)$. Except for this, the same game is played by the other $N-1$ potential bidders as in the case of an English auction. Exactly as before, the valuation threshold for entry in this case can be solved as $\hat{V}_S(V_1) = \hat{V}(V_1, C, N-1, \overline{V})$. Since $V_1 > r$, we have $\hat{V}_S(V_1) = \hat{V}(V_1, C, N-1, \overline{V}) > \hat{V}(r, C, N-1, \overline{V}) = \hat{V}_{NS}$. The difference between these entry threshold valuations reflects the entry deterrence effect of bidder 1's signaling.

For $V_1 \in [\tilde{V}, \overline{V}]$, if bidder 1 makes a bid of $B$ and is believed by the other potential bidders as having a valuation of $\vec{V}_1$, his expected payoff is

$$U(V_1, \vec{V}_1, B) = F(\hat{V}_S(\vec{V}_1))^{N-1}(V_1 - B) - C.$$

Clearly this payoff function is increasing in bidder 1's true valuation $V_1$ and the belief of the other potential bidders $\vec{V}_1$, but decreasing in his bid $B$.

In equilibrium, bidder 1 should "tell the truth" by bidding his equilibrium bid $B(V_1)$, which reveals to the other potential bidders that his true type is $V_1$. For a strictly monotonic bidding schedule to satisfy this truth-telling constraint (or incentive compatibility constraint), bidder 1's above expected payoff function must satisfy the single crossing condition, so lower valued bidders have no incentive to misrepresent their valuations. It can be checked that this condition is indeed satisfied, because the slope of the indifference curve

$$-\frac{\partial U / \partial \vec{V}_1}{\partial U / \partial B} = \frac{(N-1) f(\hat{V}_S(\vec{V}_1))(V_1 - B)}{F(\hat{V}_S(\vec{V}_1))} \frac{d\hat{V}_S(\vec{V}_1)}{d\vec{V}_1}$$

is clearly increasing in $V_1$.

From the truth-telling constraint, we can derive the differential equation that characterizes the strictly increasing bidding schedule as follows:

$$\frac{dB}{dV_1} = \frac{(N-1)f(\hat{V}_S(V_1))(V_1 - B)}{F(\hat{V}_S(V_1))} \frac{d\hat{V}_S(V_1)}{dV_1}. \tag{A2}$$

From equation (1) and $\hat{V}_S(V_1) = \hat{V}(V_1, C, N-1, \bar{V})$, we can use the implicit function theorem to derive

$$\frac{d\hat{V}_S(V_1)}{dV_1} = \frac{F(\hat{V}_S)}{F(\hat{V}_S) + (N-2)f(\hat{V}_S)(\hat{V}_S - V_1)}.$$

Together with the boundary condition that $B(\tilde{V}) = r$ (the lowest type uses the lowest possible signal), the equation (a) characterizes the strictly increasing signaling schedule.

## 4. Comparing the English and two-stage auctions without corruption: a numerical example

Because a general comparison of the expected revenue between English and two-stage auctions is too difficult, we use a simple numerical example to show that the expected revenue is higher for an English auction than for a two-stage auction when the land is "hot" under a particular characterization of hot, and vice versa. We normalize parameters by setting $v_0 = 0$, C=1. Let $r$=2. Consider the case of $N = 2$, and each bidder's valuation is uniform on $[0, \bar{V}]$, where $\bar{V} > r + C = 3$. A cold property occurs when $\bar{V}$ is relatively small, while the property is hot when $\bar{V}$ is relatively large. Admittedly this shifts the whole distribution of valuations, although the common valuation could remain the same.

For an English auction, from equation (1) it can be shown that the entry threshold valuation is $\hat{V} = 0.5r + (0.25r^2 + C\bar{V})^{0.5}$. The probability of no entry (hence no sale) is $(\hat{V}/\bar{V})^2$ ; the probability of only one bidder entering is $2\hat{V}(\bar{V} - \hat{V})/\bar{V}^2$, in which case the land will be sold at the reserve price. The probability of competitive bidding is $(\bar{V} - \hat{V})^2/\bar{V}^2$, in which case the expected revenue is the expected lower valuation of the two bidders (by revenue equivalence with the second price auction).

For the two-stage auction, we have two scenarios: low valuation scenario and high valuation scenario. The low valuation scenario occurs when $\bar{V} \le r + 2C$; then bidder 2 will not enter at all as long as bidder 1 has entered. So bidder 1's entry threshold valuation is $\tilde{V} = r + C$, and if he does not enter, bidder 2 will enter if his valuation is above $r + C$. In this scenario, the probability of no entry (no sale) is $(r+C)^2/\bar{V}^2$; the probability of only one bidder entering is $1-(r+C)^2/\bar{V}^2$, in which case the sales price is the reserve price. Note that in this low valuation scenario there will be no competitive bidding.

In the high valuation scenario of the two-stage auction ($\bar{V} > r + 2C$), if bidder 1 does not enter, then bidder 2 should enter with a bid at the reserve price when $V_2 \ge \hat{V}_{NS} = r + C$. If bidder 1 enters with a signaling bid, bidder 2 will enter only if his valuation $V_2 \ge \hat{V}_S(V_1) = V_1 + C$. From equation (A1), it can be shown that bidder 1's entry threshold valuation is given by $\tilde{V} = 0.5(r-c) + [0.25(r+C)^2 + C\bar{V}]^{0.5}$. In this scenario, the probability of no entry (no sale) is $\tilde{V}(r+C)/\bar{V}^2$. There are two cases that result in only one bidder entering: (i) bidder 1 enters with a signaling bid and bidder 2 does not enter, which happens with probability of $[(\bar{V}-\tilde{V})(0.5\bar{V}+0.5\tilde{V}+C)-0.5C^2]/\bar{V}^2$ and with a sales price equal to bidder 1's signaling bid; and (ii) bidder 1 does not enter and bidder 2 enters with a bid at the reserve price, which happens with probability of $\tilde{V}(\bar{V}-r-C)/\bar{V}^2$. The remainder of the probability goes to the case of competitive bidding.

To see that a revenue maximizing auctioneer prefers a two-stage auction over an English auction for cold properties, consider first the low valuation scenario when $\bar{V}$ is close to $r + 2C$. In our numerical example, this means that $\bar{V} \approx r + 2C = 4$. Then in an English auction the entry threshold is $\tilde{V} \approx 3.24$, the probability of no sale is about 0.656, the probability of one bidder entering is about 0.308 and that of competitive bidding is less than 0.04. Since the sales price in competitive bidding is less than 4, the expected revenue is no more than 0.776. For a two-stage auction, the probability of no sales is 0.563, and the probability of having one bidder enter is 0.438. Thus, the expected revenue of a two-stage auction is 0.875, higher than that of an English auction. Because the expected revenue is continuous in $\bar{V}$, we conclude that for cold properties a two-stage auction generates greater expected revenue than an English auction.

Now consider the other extreme case in which $\bar{V}$ is large, e.g., $\bar{V} = 24$. Then in an English auction the entry threshold is $\hat{V} = 6$, the probability of no sale is 0.0625, the probability of one bidder entering is 0.375 and that of competitive bidding is 0.563. It can be shown that the total expected revenue of an English auction is 7.5. For a two-stage auction, the threshold valuation for bidder 1 is 5.62 and the probability of no sale is about 0.03. The probability of only bidder 2 entering is about 0.205, generating an expected revenue of 0.41. From (A2), solving the differential equation, bidder 1's signaling function is $B = (0.5V_1^2 - 2.55)/(V_1 + 1)$ starting at $B = r = 2$ when $V_1 = \tilde{V} = 5.62$. It can be checked that the event of only bidder 1 entering generates an expected revenue of about 3.85, and the event of competitive bidding generates an expected revenue of 2.99. Thus, the total expected revenue of a two-stage auction is 7.28, which is less than that of an English auction.

## Data appendix.

**Comparing the estimating sample with samples of unsold properties and properties with incomplete information**

| | I. Base sample N = 2302 | II. Unsold N = 607 | III. Sold: missing price data. N= 1107 | IV. Unsold Diff (t-stat.) I-II | V. Missing price data Diff (t-stat) I-III |
|---|---|---|---|---|---|
| **Two-stage auction** | .72 | .61 | .69 | 5.11 | 1.66 |
| **Area (sq. m.)** | 54861 | 54113 | 53831 | -.09 | .25 |
| **Distance (km.)** | 19.3 | 46.4 | 13.4 | -13.6 | 7.68 |
| **Unit sale price (10,000 Y)** | .62 | n.a | .58 (n=824) | n.a. | .53 |
| **Unit reserve price (10, 000 Y)** | .37 | .21 | .31 (n=200) | 5.01 | .50 |
| **Mixed use** | .38 | .52 | .39 | -6.03 | -.54 |
| **Commercial use** | .31 | .27 | .28 | 1.99 | 1.76 |
| **Residential use** | .31 | .21 | .33 | 4.99 | -1.14 |
| **No. quarters since listing till Dec. 2007** | 8.17 | 4.74 | 9.31 | 19.8 | -6.25 |

* significant at 10% level; ** significant at 5% level or higher

The table above explores the differences in means of variables for the estimating sample versus other listings. A comparison of columns I and II (with tests of differences given in column IV) suggests unsold properties are more distant from the CBD with a lower reserve price; and are more likely to have been offered at English auction. A probit of auction type on sold or not, with controls for property characteristics including reserve price and city and year fixed effects, suggests two-stage auctions have a .076 higher probability of a sale. A comparison of columns I and III (with tests of differences given in column V) suggests sales with missing sale or reserve price data are similar to those in our estimating sample. They have similar auction type and use proportions and when data is available have similar reserve and sales unit prices.

**MLE appendix.**

**Discrete choice results. 3-equation MLE compared with 2-equation bivariate probit**
(Non-marginal effects)

| | **Competition equation (3-eq. model)** [Competition or not] (eqs 8 & 11) | **Competition equation (2- eq. model)** | **Auction equation (3-eq. model)** [two-stage auction or not (eqs. 7 & 10)] | **Auction equation (2-eq. model)** |
|---|---|---|---|---|
| **Two-stage auction** | -1.54** (.316) | -1.55** (.311) | n.a. | n.a. |
| **Ln (reserve price)** | -.057 (.061) | -.058 (.061) | -.137 (.110) | -.137 (.109) |
| **Dummy: Residential use** | .444** (.148) | .440** (.158) | -.811** (.185) | -.809** (.183) |
| **Dummy: Mixed use** | .415** (.179) | .411** (.177) | -.808** (.208) | -.806** (.207) |
| **Ln (dist. To CBD)** | -.089 (.057) | -.089 (.055) | -.156 (.139) | -.153 (.137) |
| **Ln (area)** | -.112** (.028) | -.112** (.028) | -.0040 (.052) | -.0035 (.045) |
| **Dummy: rail within 2.5 kms.** | .057 (.098) | .057 (.097) | .197* (.113) | .203* (.115) |
| **Dummy: highway within 2.5 kms.** | -.070 (.071) | -.071 (.073) | -.227** (.079) | -.224** (.081) |
| **Party secretary turnover, 1 month lead** | n.a. | n.a. | -.837** (.321) | -.815** (.290) |
| **Party secretary turnover, 1 month lag** | n.a. | n.a. | .803** (.191) | .800** (.187) |
| **Google report, Land corruption case, 3 month lead** | n.a. | n.a. | -.670** (.336) | -.678* (.367) |
| **Google report, Land corruption case, 2 month lead** | n.a. | n.a. | .974* (.525) | .959** (.515) |
| **Season, year, city dummies** | Yes | Yes | Yes | Yes |
| **N** | 2297 | 2297 | 2297 | 2297 |

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**Figure 1. Distribution of unit sales prices by auction type**
**Orange (solid) is two-stage auction; white (blank) is English auction**

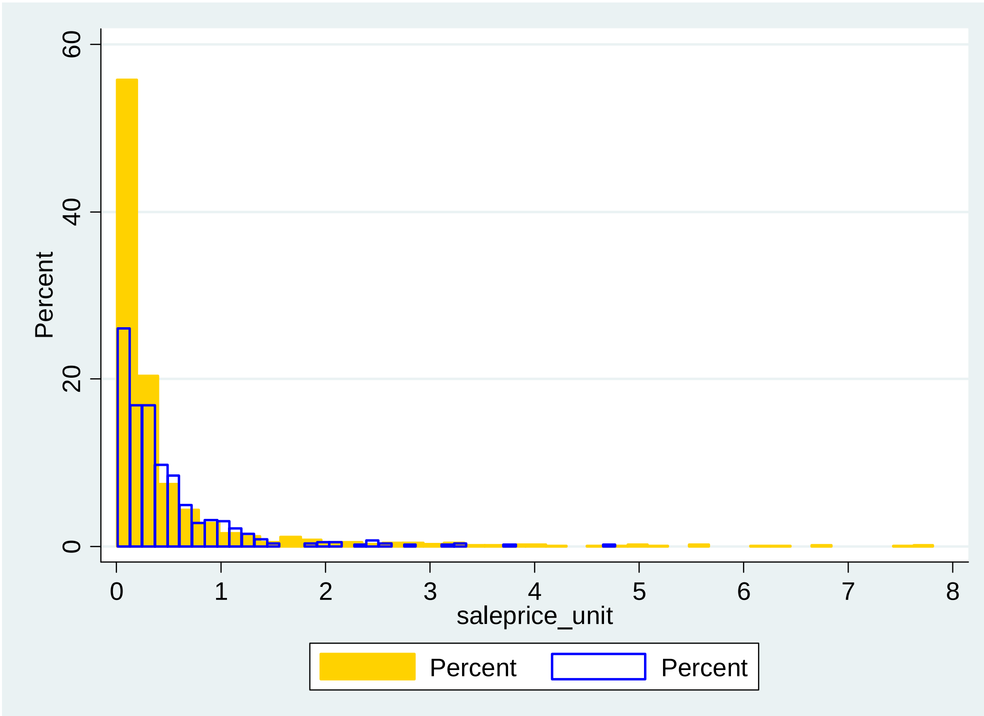


**Figure 2. Distribution of bid-reserve price ratio by auction type**
**Orange (solid) is two-stage auction; white (blank) is English auction**

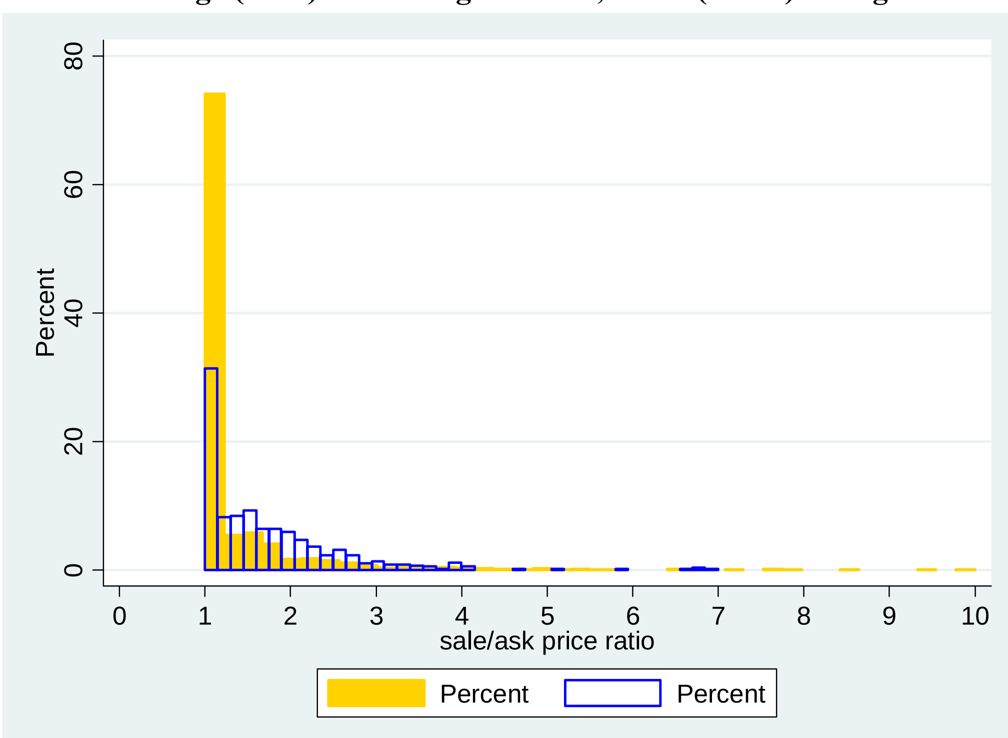

**Figure 3. For two-stage auction sales: predicted unit price if sold by two-stage (45° line) versus switching to English auction**

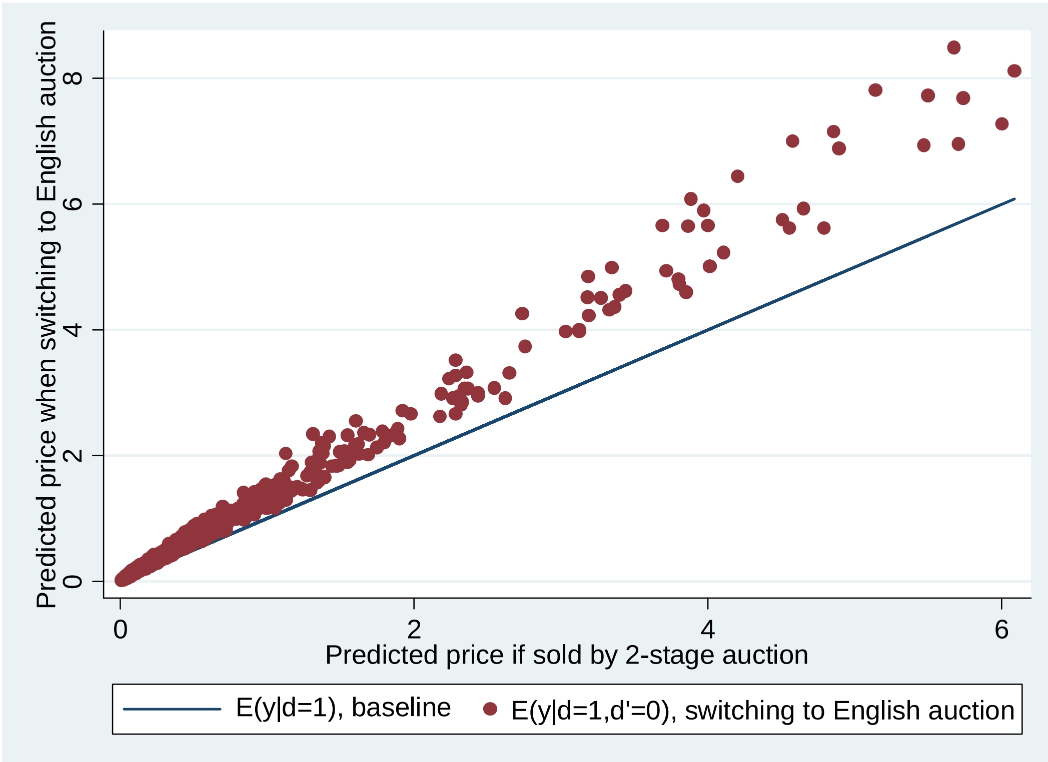

**Table 1. Beijing two-stage auctions**

| Number of bidders | Number of cases: Sales-reserve price ratio ≤ 1.005 | Number of cases: Sales-reserve price ratio > 1.005 |
|---|---|---|
| 1 | 104 | 1 |
| 2 | 3 | 6 |
| 3 or more | 0 | 75 |

**Table 2. Beijing count and spread estimations**

| | Poisson: Number of bids (robust s.e.'s) | | | Probit: Sales/reserve price ratio > 1.005 (marg. effects) | | |
|---|---|---|---|---|---|---|
| **Bidder on first day, or not (167 of 195)** | -.731** (.344) | -.638* (.338) | -8.28** (.310) | -.142 (.103) | -.144 (.111) | -.224* (.117) |
| **Residential use** | | 1.19** (.356) | 1.04** (.352) | | .284** (.097) | .272** (.106) |
| **Mixed use** | | .827* (.421) | .772* (.429) | | .216** (.095) | .213** (.105) |
| **Ln (area)** | | .205** (.092) | .131 (.085) | | .-0039 (.028) | .027 (.035) |
| **Ln (distance to CBD)** | | -.631** (.252) | -.735** (.186) | | -.171** (.070) | -.186** (.079) |
| **Ln (reserve price)** | | -.247 (.173) | -.487** (.130) | | -.0016 (.048) | -.045 (.059) |
| **Property is cleared, prior to auction** | | | 1.63** (.591) | | | .292** (.135) |
| **N** | 195 | 181 | 155 | 189 | 181 | 155 |
| **Pseudo Rsq** | .030 | .200 | .260 | .007 | .101 | .129 |

* significant at 10% level; ** significant at 5% level or higher

**Table 3. Data on auctions**

**a) Two-stage vs. English auctions**

| | Two-stage auction: Mean (N=1661) | English auction: mean (N=641) | Difference | t-stat. |
|---|---|---|---|---|
| **Unit sales price (in 10,000 yuan)** | .47 | 1.0 | -.53 | -2.64 |
| **Proportion non-competitive** | .574 | .178 | .396 | -20.4 |
| **Unit price if competitive (in 10, 000 yuan)** | .73 (n =708) | 1.13 (n = 527) | -.40 | -1.62 |
| **Area (in sq. meter)** | 55289.96 | 53751.1 | 1538.86 | .30 |
| **Distance to CBD (in km)** | 19.9 | 17.8 | 2.1 | 1.86 |
| **Commercial use** | .38 | .14 | .24 | 13.3 |

**b) Commercial vs. residential and mixed use properties**

| | Commercial: mean (N=716) | Residential and mixed use: Mean (N= 1586) | Difference | t-stat. |
|---|---|---|---|---|
| **Unit sales price (in 10, 000 yuan)** | .617 | .615 | .002 | .026 |
| **Unit price if competitive (in 10, 000 yuan)** | .98 (n=289) | .88 (n=946) | .09 | .55 |
| **Area (in sq. meter)** | 31354.72 | 65473.59 | -34118.87 | -8.52 |
| **Distance to CBD (in km)** | 18.47 | 19.67 | -1.20 | -1.03 |
| **Proportion two-stage auction** | .88 | .65 | .23 | 13.17 |
| **Proportion non-competitive** | .596 | .403 | .193 | 8.72 |

**Table 4. Two-stage auction, or not**[1]

| | Probit: marginal effects | Probit: marginal effects |
|---|---|---|
| **Ln (reserve price)** | -.040<br>(.031) | -.041<br>(.030) |
| **Dummy: Residential use** | -.255**<br>(.058) | -.250**<br>(.055) |
| **Dummy: Mixed use** | -.245**<br>(.064) | -.241**<br>(.062) |
| **Ln (dist. To CBD)** | -.044<br>(.038) | -.044<br>(.037) |
| **Ln (area)** | -.0015<br>(.013) | -.0037<br>(.013) |
| **Dummy: railway within 2.5 kms.** | .055*<br>(.028) | .057*<br>(.030) |
| **Dummy: highway within 2.5 kms.** | -.066**<br>(.021) | -.069**<br>(.022) |
| | | |
| **Lagged change in fiscal strain** | | -.544**<br>(.236) |
| **Xinhua corruption report, 2 month lead from listing** | | -.016<br>(.016) |
| **Xinhua corruption report, 1 month lead** | | .021*<br>(.012) |
| **Party secretary turnover, 1 month lead** | -.300**<br>(.127) | -.314**<br>(.131) |
| **Party secretary turnover, 1 month lag** | .157**<br>(.022) | .162**<br>(.018) |
| **Google report, Land corruption case, 3 month lead** | -.212*<br>(.136) | -.207*<br>(.129) |
| **Google report, Land corruption case, 2 month lead** | .183*<br>(.040) | .186**<br>(.037) |
| **Season, year, city dummies** | Yes | Yes |
| **N** | 2302 | 2302 |
| **Pseudo Rsq** | .37 | .36 |
| **Implied *F*-Stat: adding bottom panel instruments** | 8.1 | 6.6 |

* significant at 10% level; ** significant at 5% or higher level.
All standard errors are robust clustered by city-code.

**Table 5. Baseline Case: Unite Sales Prices [ln(sales price/area)]**

| | OLS | Heckman | | IV |
|---|---|---|---|---|
| | | 2-step | MLE | LIML |
| **Dummy: two-stage auction [2SLS]** | -.170** (.037) | -.410** (.122) | -.707** (.217) | -.428** [-.428*] (.112) [(.225)] |
| **Ln (reserve price)** | .923** (.028) | .916** (.012) | .907** (.025) | .915** (.015) |
| **Dummy: Residential use** | .023 (.049) | -.018 (.033) | -.068 (.078) | -.021 (.036) |
| **Dummy: Mixed use** | .078** (.034) | .039 (.032) | -.0091 (.059) | .036 (.034) |
| **Ln (dist. To CBD)** | .0083 (.037) | -.000064 (.014) | -.010 (.037) | -.00069 (.017) |
| **Ln (area)** | -.069** (.011) | -.069** (.0075) | -.070** (.013) | -.069** (.011) |
| **Dummy: railway within 2.5 kms.** | -.025 (.035) | -.015 (.026) | -.0034 (.035) | -.015 (.025) |
| **Dummy: highway within 2.5 kms.** | -.067 (.038) | -.077** (.023) | -.089* (.046) | -.077** (.023) |
| **Season, year, city dummies** | Yes | yes | yes | yes |
| **N** | 2302 | 2302 | 2302 | 2302 |
| **Rsq** | .85 | | | .84 |
| ***Lambda* [*rho*] {Sargan p-value; 4 instruments}** | | .140** (.069) | [.641** (.235)] | {.15} |

* significant at 10% level; ** significant at 5% level or higher. All standard errors (except in Heckman 2-step estimation and IV LIML) are robust clustered by city-code.

**Table 6. Probability sale is competitive:**

| | **Ordinary probit** | **Bivariate recursive probit MLE** | |
|---|---|---|---|
| | **Marginal effects** | **Marginal indirect effects** | **Marginal direct effects** |
| **Dummy: two-stage auction** | -.338** (.079) | n.a. | -.427** (.085) |
| **Ln (reserve price)** | .-016 (.027) | .085 (.067) | -.023 (.024) |
| **Dummy: Residential use** | .216** (.055) | .405** (.131) | .172** (.062) |
| **Dummy: Mixed use** | .205** (.049) | .405** (.156) | .161** (.069) |
| **Ln (dist. To CBD)** | -.028 (.021) | .094 (.085) | -.035* (.022) |
| **Ln (area)** | .-045** (.012) | .002 (.028) | -.045** (.011) |
| **Dummy: rail within 2.5 kms.** | .013 (.036) | -.123* (.076) | .023 (.039) |
| **Dummy: highway within 2.5 kms.** | -.019 (.029) | .137** (.067) | -.028 (.029) |
| **Season, year, city dummies** | Yes | Yes | Yes |
| **N** | 2297 | 2297 | |
| **Rho** | | .383** (.157) | |
| **Rsq** | .22 | | |

* significant at 10% level; ** significant at 5% level or higher. All standard errors are robust clustered by city-code.

**Table 7. Auction price differences under competition: data**

| Samples | Number | | Percent: spread > 1.005 | | Median of spread | | | |
|---|---|---|---|---|---|---|---|---|
| | Two Stage . | Eng . | Two Stage | Eng. | Two Stage | Eng. | Med diff. Eng. > 2-S. Chi2 p-value | Rank diff. WMW: p-value |
| **all** | 1661 | 641 | .43 | .82 | 1.0 | 1.49 | .000 | .000 |
| **Prob. comp. >0.5** | 590 | 574 | .69 | .85 | 1.17 | 1.51 | .000 | .000 |
| **Prob. comp. >0.6** | 377 | 535 | .74 | .88 | 1.25 | 1.54 | .000 | .000 |
| **Prob. comp. >0.7** | 212 | 503 | .77 | .90 | 1.39 | 1.56 | .029 | .017 |
| **Prob. comp. >0.8** | 89 | 406 | .78 | .92 | 1.47 | 1.65 | .360 | .140 |
| **Prob. comp.> 0.85** | 49 | 328 | .84 | .93 | 1.91 | 1.68 | .348 | .245 |
| **Prob. comp.> 0.9** | 14 | 240 | 1 | .95 | 1.84 | 1.83 | .783 | .991 |

**Table 8. Sales prices: "Competitive" sales only**

| **All sales where spread > 1.0005** | | |
|---|---|---|
| | **OLS** | **MLE (selection on auction type and competition)** (eqs. 7a – 11) |
| **Dummy: two-stage auction** | -.031<br>(.071) | -.137<br>(.414) |
| **Ln (reserve price)** | .870**<br>(.041) | .867**<br>(.051) |
| **Dummy: Residential use** | -.157*<br>(.075) | -.162<br>(.103) |
| **Dummy: Mixed use** | -.061<br>(.042) | -.065<br>(.068) |
| **Ln (dist. To CBD)** | .025<br>(.048) | .020<br>(.047) |
| **Ln (area)** | -.097**<br>(.027) | -.098**<br>(.032) |
| **Dummy: there is railway within 2.5 kms.** | -.049<br>(.052) | -.049<br>(.053) |
| **Dummy: there is highway within 2.5 kms.** | -.102<br>(.064) | -.110<br>(.077) |
| **Season, year, city dummies** | Yes | Yes |
| **N** | 1235 | 1235 |
| $\sigma_{\varepsilon}$ | | .510**<br>(.060) |
| $\rho_{u\varepsilon}$ | | .114<br>(.437) |
| $\rho_{v\varepsilon}$ | | .088<br>(.212) |
| $\rho_{uv}$ | | .374**<br>(.186) |
| Rsq | .82 | |

Significant at 10% level; ** significant at 5% level or higher. OLS s.e.'s are robust, city clustered.